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CONTENTS

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COVER PICTURE

Luc Tendstedt driving his $1\frac{1}{2}$ in. scale modified "Highlander" at Guildford. Colour photograph by D. E. Lawrence.

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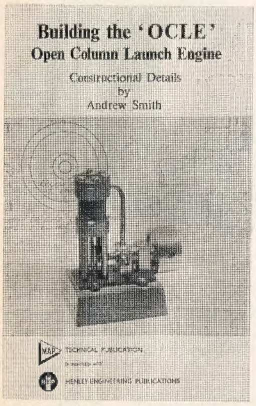

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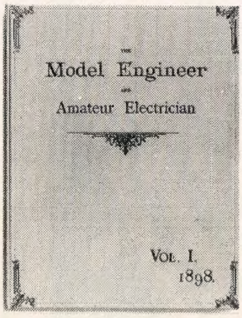

Model Engineer is a respected and popular magazine dating from 1898 when it was founded by the late Percival Marshall, the original publisher and editor. Early copies are much sought after by enthusiasts, and we have now produced a fine facsimile reproduction of the very first volume covering six months in 1898. The casebinding reproduces the style of the original and all covers and advertising pages are included. Much of the material is of practical interest to modern enthusiasts, but the entire book gives a fascinating and nostalgic reminder of the early days of model engineering.
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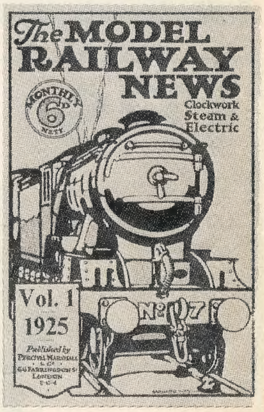

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SMOKE RINGS

A Commentary by the Editor

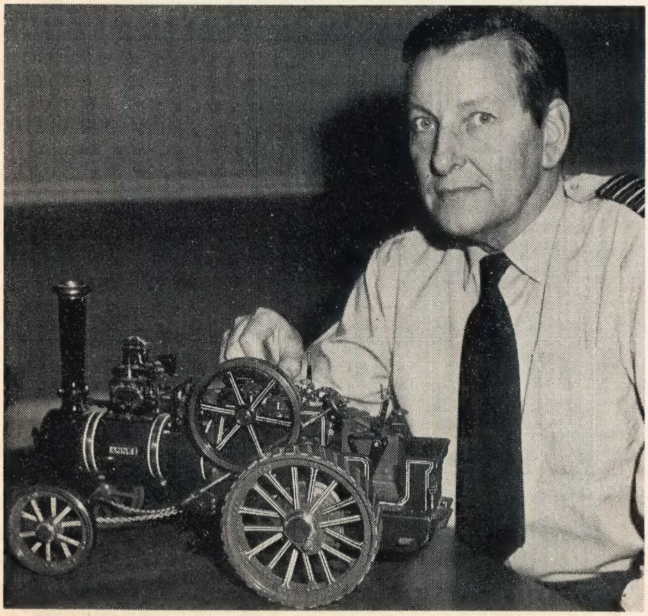
Invitation to Visit Japan

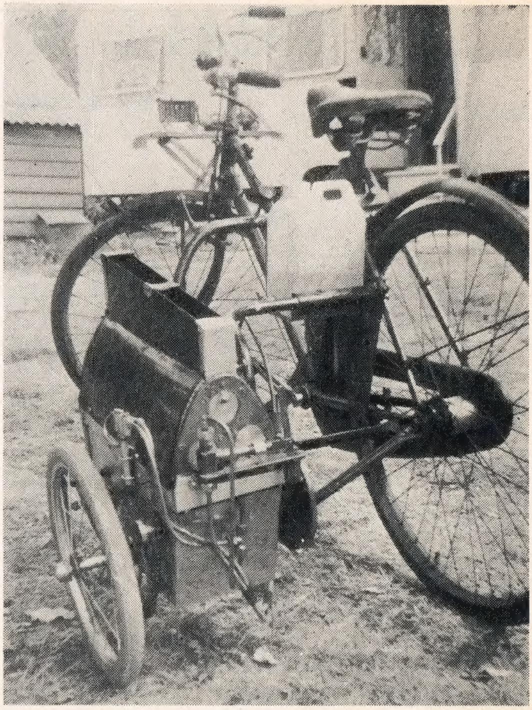
An International Steam Locomotive Festival and Convention is to be held in Japan from 28 July to 23 August 1977. The Festival is being organised by the Japan Miniature Club of Tokyo, and expenses are to be paid by the Sumitomo Real Estate Co. Ltd. and the Sumitomo Mutual Life Insurance Co., of Tokyo, and the Hokkaido Broadcasting Co. Ltd. of Sapporo. An invitation to this Festival has come about as the result of the visits of Japanese model engineers to the International Rallies organised by the Guildford M.E.S.

Applications are invited from model engineers who can comply fully with the following conditions:

1. Owners of 5 in. gauge locomotives capable of hauling a minimum of twelve passengers during the period of the Festival.
2. Owners of model traction engines capable of hauling a minimum of four passengers continuously during the period of the Festival.
3. Owners must be fully qualified to repair any major breakdown that might occur. (Access will be possible to Japanese M.E. workshops.)
4. Applicants must be confident of being at ease in Television interviews and as "British representatives" at functions that may be organised and attended not only by host members but by European and other world representatives.
5. Applicants must be medically fit to undertake the strenuous tour.
6. Applications would be supported by local Model Engineering Societies if required.

The model traction engine built by Group Capt. Hepburn.





Another view of the steam-driven bicycle made by Mr. W. A. Day of Headington (see also page 1125—19 November issue).

Those interested should apply for full details by foolscap self-addressed and stamped envelope to Mr. Charles Webster, 49 The Oval, Wood Street Village, Guildford, Surrey. Serious applications only please. Mr. Webster emphasises that neither he, nor the Guildford M.E.S., will be held responsible for any loss, cost or injury sustained by applicants in connection with the Festival.

Stolen Model Tram

A model tram was stolen from the window of the Gateway Building Society, Cheapside, London, recently. It is for $3\frac{1}{2}$ in. gauge and is an open top double-deck 4-wheel car painted brown and cream and lettered Bexley Council Tramways No. 9. Should any reader see this model or be offered it for sale, would he please contact the City of London Police, Wood Street.

Model Traction Engine

My picture shows a 1 in. scale traction engine based on a design by Ransomes, Sims & Jefferies. It was built by Group Capt. R. K. Hepburn of R.A.F. Bawtry, Yorks.

A SMALL ROTARY TABLE

Part II

by George H. Thomas

From page 1195

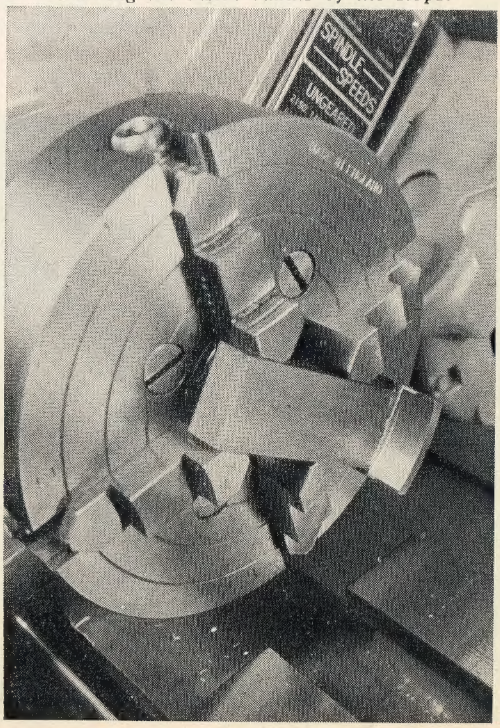
Stops and Nuts

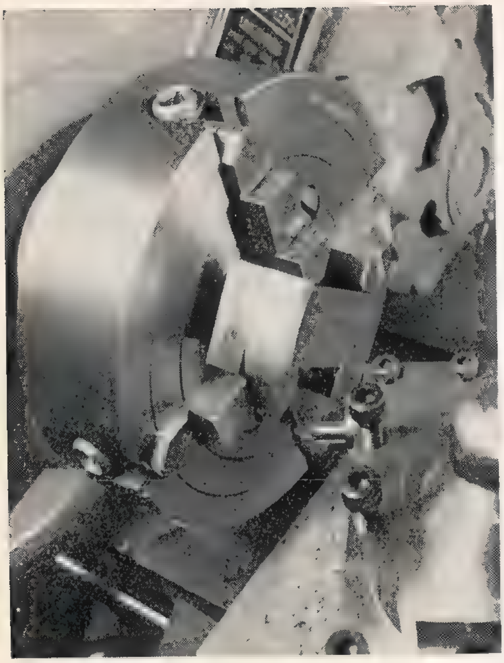
To make these we want a soldering block (15) which is a piece of 1 in. x $\frac{1}{2}$ in. b.m.s. one end of which is finished accurately flat and square both ways and having two centres "A" and "B" marked on the centre line. We have to start with the stops (sorry about that!) which are made from a $1\frac{1}{8}$ in. length of 1 in. x $\frac{1}{4}$ in. b.m.s. Clean one end of this by rubbing on a fine flat file. After preliminary tinning of this and the end of the solder block, it is sweated to the end as shown in 15 and 16. This will take quite a time to cool and the two parts must be held up into good contact until set. Wash off. Set the block up in the 4-jaw chuck with centre "B" running true (15). When setting up hold the block back on $\frac{1}{2}$ in. parallels, not forgetting to remove them before running the lathe! See photos. Turn the outside for about $\frac{1}{2}$ in. until it *just* cleans up in the centre. Next turn the inside surface; a photo shows this being done with a $\frac{1}{4}$ in. dia. tool-bit held in a boring-bar holder and with the turret swung round to a suitable angle. This operation is continued with light cuts and fine feeds until the chord is rather more than 1 in. (see photo). For readers' benefit I made a note that most turning on these stops and nuts was done at 200 r.p.m.; cuts .006 in. deep and feed about 250/ in. Face off the front edge and remove from chuck. Mark out, drill and c'bore for 4 BA screws after which it remains only to saw down the lines and then sever the stops from the unwanted stock. As seen in the photos, I made a machine job of this, which was quicker as the parts came away completely finished apart from a light de-burring of the edges.

The making of the vee-nuts starts off in a similar manner (17). Once again a $1\frac{1}{8}$ in. length of 1 in. x $\frac{1}{4}$ in. b.m.s. is sweated to the end of the block which is set up as before but with centre "A" running true. Turn out the inside curve first until the chord is about 1 in. across, then turn down the outside until the radial thickness is 9/64 in. (.141 in.). Face off the front end, remove from lathe, mark out and saw off the curved strip $\frac{3}{8}$ in. wide—to finish .321 in. Back to the block. First, from centre "B" scribe an arc across the face at 1 17/32 in. radius (18); this will pass at 1/16 in. from the "business end" of the block. Set up again in 4-jaw chuck with the centre "B" running true; drill, bore and ream $\frac{1}{2}$ in. dia. and take a light skim over the face to about 1 in. dia. If the block had been backed out from the chuck face with 9/16 in. parallels it would be possible, at this set-up, to turn the end of the block to receive the embryo nuts, if not, the end will have to be prepared after mounting on a mandrel, which raises another matter. Every year there must be hundreds, if not thousands, of "stub mandrels" made and thrown away; why not make a job of them and keep them for future use? One photo shows not only the block which has now served its purpose but also one of my standard mandrels which was used. These are turned all over between centres so that they can be used either in a chuck, with or without tailstock support, or between centres. One end is turned to a fraction size, as nearly as possible plus or minus zero, and threaded for a suitable nut. In addition, it is furnished with clamping collars and adaptors for larger sizes. A few of these will cover almost any job that is likely to crop up.

It is now necessary to turn the end of the block down to within about 1/32 in. of the scribed line and then turn down to the line leaving about 1/32 in. step at the end. See (19). Tin the parts as before and sweat the curved nut-blank to the block; the little ridge will locate and hold it true. Mount on

Turning the inside radius of the stops.





Showing the tool used for inside turning.

the mandrel with trued facing against the shoulder; grip in chuck and support end on tailstock (jobs involving intermittent cuts are best not done between centres). With top-slide set round 70 deg. (strictly speaking 110 deg.), bevel the outer face, removing entirely the 1/32 in. step (21). Next, with top-slide set to 70 deg., the opposite angle, and with a L/H knife tool turn down the sloping side, feed-

Slitting the stops using vertical attachment swung round 90 deg., vice swivelled to obtain radial cuts.

Set-up for drilling and counterboring holes in stops.

ing with the top-slide, as before (22). Carry on until the width across the top is as nearly 7/32 in. as can be read with a rule. Rules vary a great deal; many of the modern dull-chrome plated types which are excellent for clarity have graduation lines rather too wide for very close working. Examine the hundredths; it will often be found that the lines are as wide as the spaces, i.e. .005 in. wide. My best rule is a 12 in. Chesterman "Rustless" No. 417D/3 on which the lines are about .003 in. wide and with this and an eye-glass one can work to about .002 in. An alternative method is to set and lock the micrometer at .220 in. and reduce the width until the anvils will *just,* and only just, engage both sides at the same time—assuming that the edges of the anvils have not been rounded by much use. The remaining work on the nuts is quite straightforward, but owing to their shape they would be difficult to hold in a vice without damage, so all the remaining operations are best carried out before separating from the block. After marking out—be sure to get the tapping holes in the centre of the 7/32 in. width—drill, tap and saw down into the block. Wipe off excess solder from the undersides whilst still hot.

Now for the exciting bit! Try a nut in the groove; put it in from the back and with a 4 BA screw in the tapped hole, it should be possible to pull the nut outwards to within about 20 to 30 thous.—say a bare 32nd—of the top of the groove. If this is so, a very good job has been done (or the

A Stirling Cycle Engine

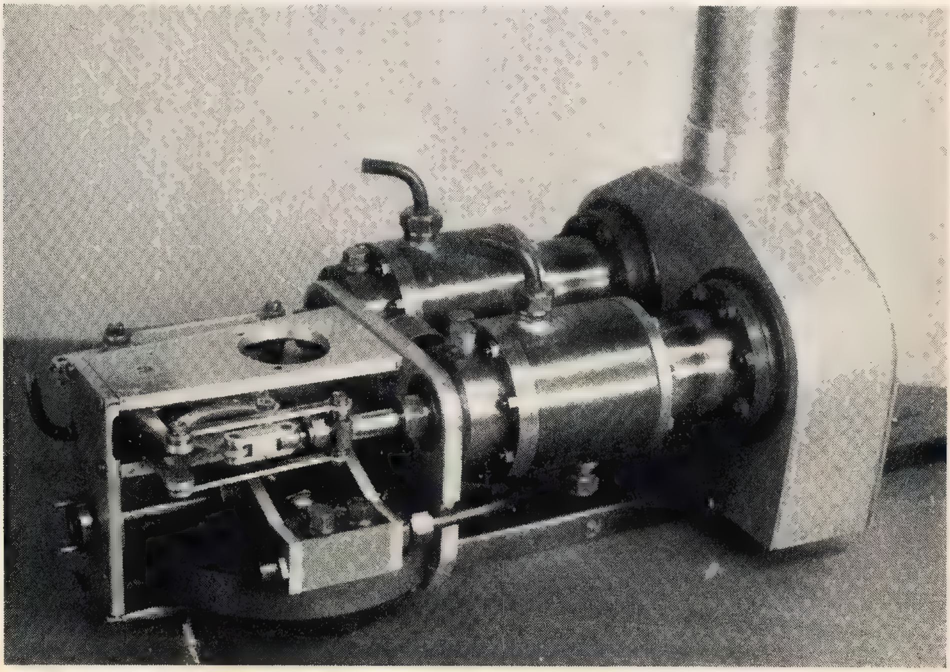
by J. Henshall

BEFORE INTRODUCING this Stirling engine, I would like to acknowledge the stimulation of interest in these engines given by Bill Newman and Ernie Tobias; Bill for showing that the model hot air engine with its separate displacer and power cylinders provides an adequate power plant for ship models, and Ernie for his comprehensive collection of published material on Stirling engines and their modern developments.

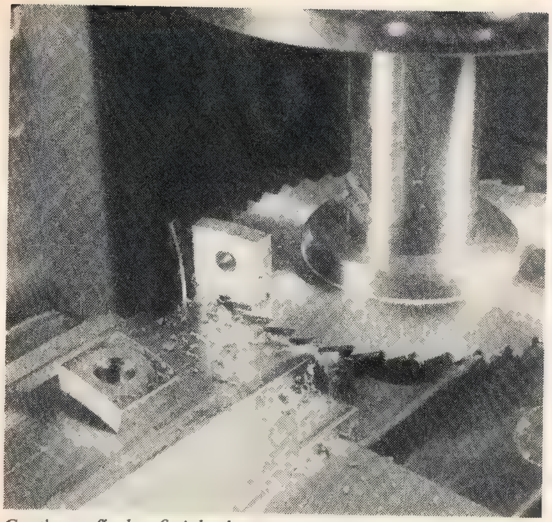
The principal objective of my exercise was to produce a Stirling cycle engine as an acceptable alternative power plant for a model steam tug within the constraints of the available space and displacement, with methylated spirit firing under natural draught and within the limited capability of my modest workshop and its material collection. Somewhat secondary objectives were to show the benefits of regeneration and pressurisation on the performance of such engines, perhaps hopefully to obtain powers comparable to those of simple steam plants as used in prototype models. Other factors which are significant to the performance and to which attention would be given include effective utilisation of the available hot and cold temperatures, compression ratio and reduction of the heat flow through the displacer cylinder walls and piston from the hot to the cold zone.

Thermodynamic theory of heat engines shows that the power output of an engine is directly related to the mean pressure over the power stroke, hence the benefits of pressurisation and higher compression ratio for increased power from a given working cylinder volume in a Stirling engine. Geometrical examination of these engines readily shows that the displacer cylinder volume is the major part of the clearance volume, i.e. the residual volume in the working space with the power piston at top dead centre, and that compression ratios as used in I.C. engines are just not possible. Dead space such as in the connection between separate displacer and power cylinders, the transfer area around the displacer and any regenerator volume further reduces the compression ratio. The highest ratio seen in technical literature is in the Philips rhomic engine, stated to be 2 to 1. Typically, small hot air engines have the ratio of the working volume (i.e. piston area $\times$ stroke) of the displacer to the working volume of the power cylinder at values of between 1.5 and 3.0 giving maximum possible compression ratios of 1.6 and 1.33 respectively in engines having separate power and displacer cylinders.

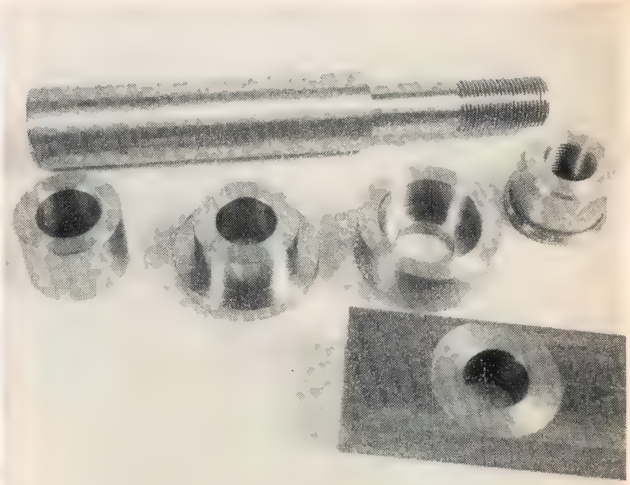
Compression ratio in the Stirling cycle does not effect the thermodynamic efficiency which, in the ideal cycle is determined by the ratio of the temperature difference between the hot and cold zones



The completed Stirling cycle engine built by J. Henshall of Victoria, Australia.



Cutting off the finished stops.



Standard ½ in. mandrel and some adaptors.

errors have cancelled each other!). Although I have stressed the need for accurate working everywhere, the layout and dimensions do provide a very generous allowance to compensate for errors in working.

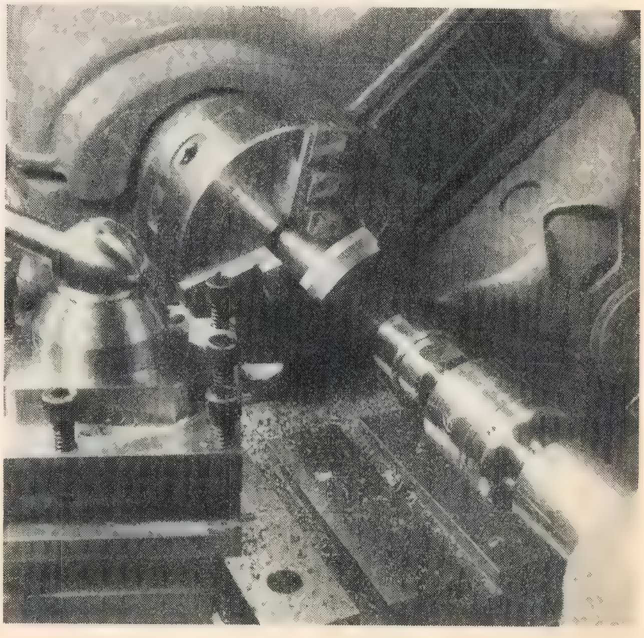
The stop block (5) is made a *tight* fit in the ½ in. groove in the base and its inner face should just clear the 3⅜ in. dia. of the table. It is held firmly in place by a 4 BA socket head screw. Drill the base tapping size (No. 32) and transfer into the block before opening to No. 27 and c'boring. Note that the upper portion of the block against which the stops abut has its two edges bevelled to bring them radial and so provide proper face contact. The angle is about 8 deg. either side.

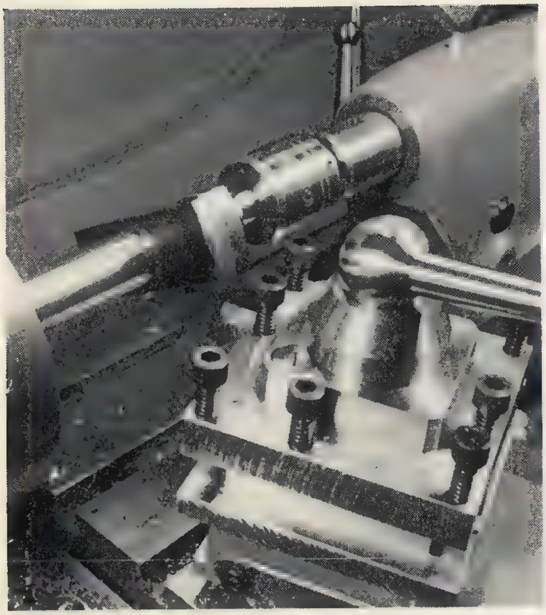
Milling the Tee-slots

If it is decided to graduate the edge in degrees it is best done at this stage as the graduations could serve for spacing the tee-slots. My table was in use for a very long time without graduations but I have since found them to be very useful for setting up. For those who would like to add the graduations I will give a few notes at the end.

The tee-slots are best done on a vertical miller, preferably mounted on a rotary table for indexing, but they can quite readily be cut in the lathe as mine were. In the first place the table should be completely assembled with the ring-nut a little on the tight side and then mounted on the vertical-slide set square across the axis and with the stop block towards the operator. Bring up the stops, one on either side of the block, so that there is no freedom. Whilst I know from experience that the stops with their dovetail nuts hold the table very firmly against rotation I am not confident that they would stand up to the loads imposed when the tee-slot cutter is being entered at the outer end of the slot. The short table of the swivelling vertical-slide is almost entirely covered by the base of the rotary table and provides no anchorage for any further clamps, but if the table is held to the slide by the two lower bolts, longer bolts in the upper tee-slot, passing through the holes in the base, could carry a clamping bar across the face of the table, thus serving a dual purpose. With this arrangement the stops would still be used for positioning but clamping against cutter loads would be effected by the

Turning down the first 20 deg. angle on dovetail nuts.



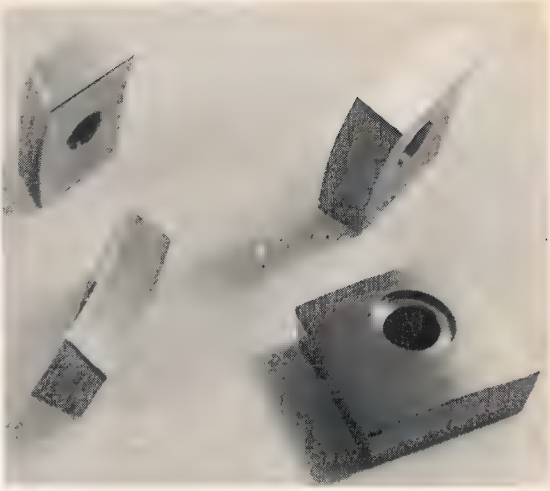


Turning down the second side of nuts.

bar. Bring the centre of the table up to lathe centre-height, note the reading and whether "up" or "down".

The proper tool to use for the initial groove is a ¼ in. slot drill (two-lipped cutter) which will cut very close to width and will not be so readily broken or damaged as an end-mill. Commercially, a ¼ in. slot-drill would be used at cuts up to ⅛ in. deep but on a vertical-slide I would be inclined to reduce this to about 1/16 in. Feed in, from the leadscrew handwheel, to a total depth of 5/16 in. After reaching full depth, another cut of about 7 or 8 thou. should be taken at the top and bottom to give a reasonable clearance over ¼ in. As this is "two directional" working, be careful of the direction of backlash in the feedscrew—hence the suggestion to note whether "up or down".

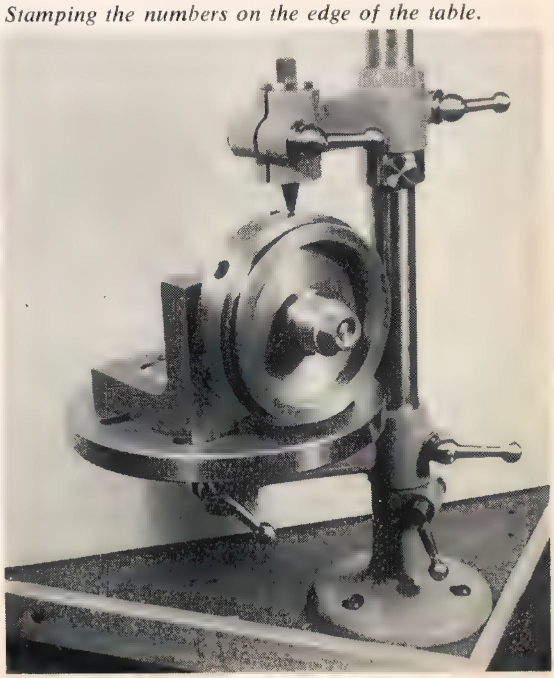
Nuts, already slit down and drilled, being tapped 4 BA.



Finished set of stops and nuts.

Having produced the first groove, return the slide to its original setting and lock it again (I forgot that vital operation before!); change the cutter for the tee-slot cutter shown in detail 23 and feed up the table by the leadscrew until it touches the face of the cutter; withdraw by the cross-slide and feed in another 5/16 in. as read on the L/S handwheel. Everything is now set to do the under-cutting at a speed of about 400 r.p.m. and the use of plenty of soluble oil to wash away the chips. Carry on until

Stamping the numbers on the edge of the table.



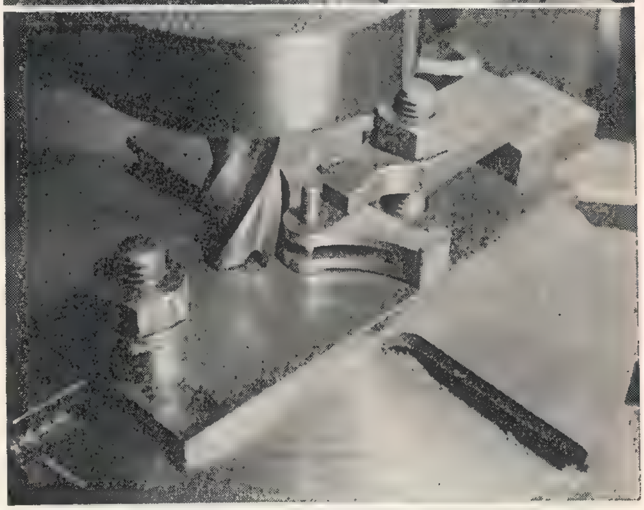
the "neck" of the cutter touches the end of the slot. Stop machine and wind out.

Now release the stops and the upper strap and turn the table to bring the slot vertical above the centre. Square up with a square off the bed, bring up and tighten the stops against the block and clamp up. Repeat previous process to produce the four slots.

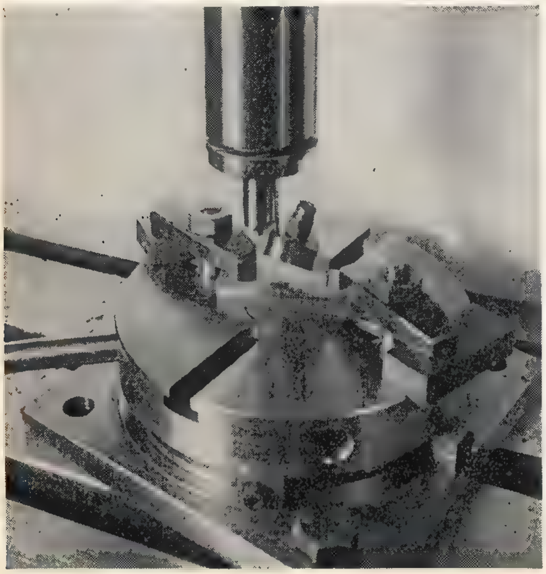
The holes for the tommy-bar can be drilled with a 5/16 in. drill to give a reasonably close fit on a bar made from 5/16 in. b.m.s., especially if it is used to open up a previously drilled hole, tapping size (No. 7) for $\frac{1}{4}$ in. Whitworth thread. The tapping at the bottom of the holes is to engage a short threaded portion, about 3/16 in. long, at the end of the bar which will prevent it from falling out when turned down below the horizontal. A couple of turns is all that is necessary and it will help to keep the blood pressure down.

About the last remaining jobs to be done are to give the base casting a few coats of paint and to press the pivot pin into the table and, holding the projecting part at the back in the chuck, face off the head of the pin until it is exactly flush with the surface of the table.

Whilst a few $\frac{1}{4}$ in. BSF tee-bolts of various lengths might be useful, it will be found that two or three tee-nuts, tapped 2 BA, will be even more so as they can be used with any length of screw and socket heads take up much less room than $\frac{1}{4}$ in. nuts. Make one of the tee-nuts with its tapped hole near to one end which will enable it to be used much closer to the centre of the table.



On right: Photographs Nos. 17 and 18.
Below: Photograph No. 19. A tricky piece of milling on a Spencer spring case.



The Table at Work

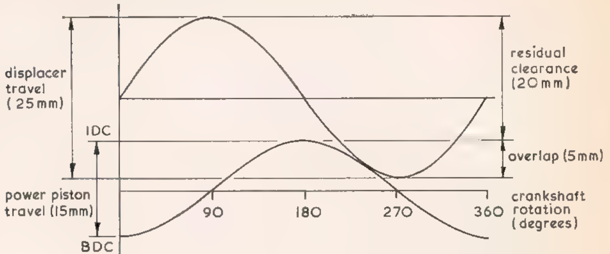
Photos Nos. 17 and 18 illustrate some milling operations on C.I. brake blocks. In 17, a partly machined block is shown mounted on a simple fixture for machining the surface down to leave a reinforcing bar. The work was traversed past the cutter until the centre of the radius was in line with the centre of the cutter (a drop-out stop was used for this point). The table was next rotated 180 deg. between the stops and the traverse continued again in the same direction to complete the operation which was done, probably, in less than a minute and the direction of movement of the work was, at all times, against the direction of rotation of the cutter. No. 18 shows a cutter completing the end radius to blend into the larger radius. The stops were set for a smaller angular travel. No. 19 shows a home-made concave radius end-mill being used to form a radius which tapered away to nothing on either side. The item being made is a Spencer spring cup.

To be continued

to the absolute temperature of the hot zone. Compression ratio is therefore only significant to the power obtainable from a given engine capacity. However, being aware of the performance of the Westbury / Robinson model before and after modification to double the displacer diameter, some guide to the choice of the ratio between the displacer and power cylinder working volumes seemed essential. Examination of available thermodynamic relationships for the Stirling cycle and its ideal P-V (indicator) diagram does not disclose any critical relationship of this ratio to engine parameters such as hot and cold zone temperatures or their difference, mean working pressure, working fluid characteristics or any other factors and it could only be concluded that the poor performance of the Westbury design was due to either leakage losses of the working fluid during the compression and expansion strokes or excessive friction absorbing the power available. The Robinson layout with the cold end virtually located in the hot flue gases obviously has a smaller working temperature difference across the displacer and hence less work available than engine arrangements having horizontal displacer cylinders. Optimisation of the compression ratio (as determined by the ratio of displacer to power cylinder volumes) has yet to be resolved.

Consideration of the above factors guided the design and were significant in the concept finally selected for construction; other important decisions were water cooling for maintaining a low temperature cold sink, twin power cylinders as an alternative to an enclosed crankcase to allow pressurised operation, a firebox and flue arrangement in which the hot gases are well separated from the cold zone and the power cylinders, an output shaft aligned to directly couple to the ship's propeller shaft and the complete engine to pass through a deck opening of 110 mm. (4.25 in.) width. Generally, if a novel feature could be argued to be beneficial to engine performance and its inclusion was practical, then it was incorporated; this probably explains features the purpose of which are no longer clear . Whether they have been helpful cannot be proved but at least they have not been catastrophic.

The engine layout, which evolved during many lunch hours of doodling, started as a separate displacer / power cylinder arrangement with trunk power pistons, twin cylinders providing the static balance for pressurised operation, and the working fluid (air) being pumped through separate check valves into each working cylinder. However the problems of compactness, excessive dead space in the transfer pipe between the displacer and power cylinders, or possible high pumping losses, and an adequate separation of the firebox and flue from the cold end and working parts remained unsolved



$$\text{Compression ratio} = \frac{\text{working volume} + \text{clearance}}{\text{clearance}} = \frac{15+20}{20} = 1{\cdot}75$$

Fig. 1

after many attempts. Gears and multiple cranks were not acceptable solutions. The concept of Stirling's patent in which the displacer and power piston are co-axial in a common cylinder was then considered and in conjunction with a simple phase shift mechanism evolved in the earlier studies and which required only a single crank, an attractive layout was found, accepting the use of a pair of bevels to drive to the propeller shaft.

The co-axial arrangement was not favoured initially as it requires closer concentricity tolerances and an additional gland, but examination of the displacer and power piston motions showed that, for a given ratio of displacer working volume to power working volume, a higher compression ratio can be obtained than with the separate cylinder arrangement. This is due to the overlap which is possible for the displacer and power piston travels as shown in Fig. 1 where for a displacer / power volume ratio of 1/66 a compression ratio of 1 : 75 is obtainable, compared to 1 : 60 available in the separate cylinder arrangement. This value of 1 : 66 seemed a reasonable compromise for the test engine, being at that end of the range of ratios used commercially, which gives the higher compression ratios. It was only accepted after much

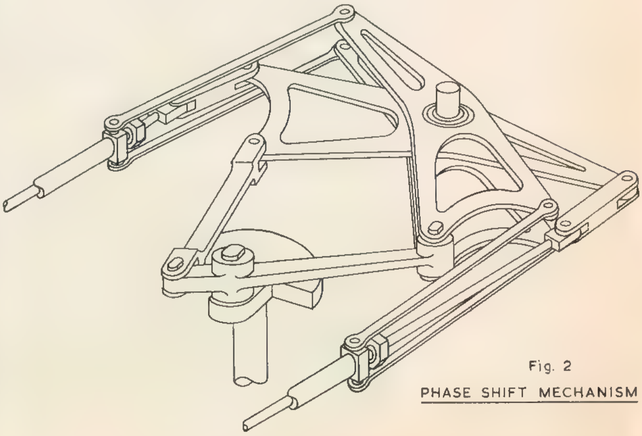


Fig. 2
PHASE SHIFT MECHANISM

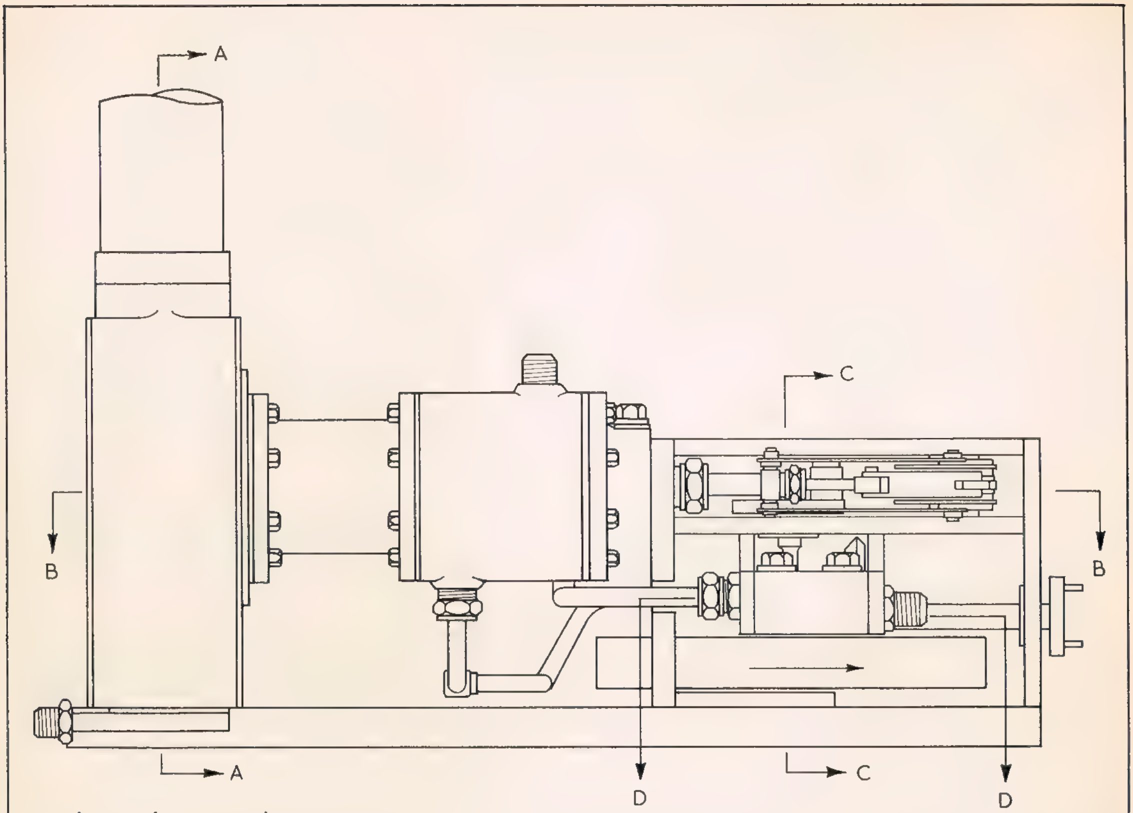


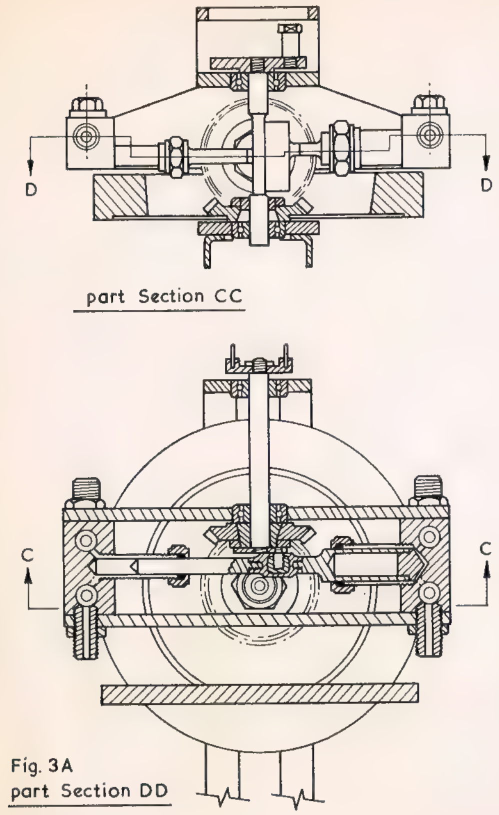
Fig. 3 Side elevation

pondering, particularly as it is near the maximum that could be obtained in the phase shift drive.

A sketch of the phase shift mechanism is shown in Fig. 2. It uses a single crank with two connecting rods whose lines of action are at 90 deg. to each other to drive through rocking levers the two power pistons and displacers, short connecting links being used between the rocking levers and the piston rods. The connecting rod for the displacer drive is driven by an extension of the connecting rod for the power pistons, not by the crankpin. This combined with a small lever ratio gain in the rocking lever provided a displacer travel of 1.66 times the power piston travel. Also with this arrangement the angular velocity of the connecting rod for the power pistons, when moving across dead centres, provides additional velocity to the displacers which are then moving between dead centres. In consequence the displacers have a slower velocity, almost a dwell, at dead centres, a characteristic closer to the ideal Stirling cycle.

The accompanying photograph gives an overall view of the engine, whose general arrangement is given in Fig. 3. Fig. 4 details items of the mechanism. The assembly is 195 mm. (7.6 in.) long excluding the fuel tank and its mounting, 108 mm. (4.25 in.) wide and 88 mm. (3.5 in.) high, excluding the 200 mm. (8 in.) flue and weighs 1.65 kg. (3.6 lb.) of which 0.35 kg. (0.75 lb.) is flywheel, fortunately located in an ideal position for ship's ballast. The cylinders are 25.4 mm. (1.0 in.) bore, common to both power piston and displacer, which have strokes of 15 mm. (0.6 in.) and 25 mm. (1.0 in.) respectively. The effective diameter of the displacer is 22.9 mm. (0.9 in.), the clearance of 1.2 mm. (0.05 in.) being used to accommodate an aluminium foil regenerator incorporated around the displacer body.

The power of the engine has not been measured; however its no-load speed, by strobotach, is 1500 r.p.m., and it will slug away happily at 250 r.p.m. under the load provided by quite firm pressure between thumb and forefinger on the 4.7 mm. (0.187 in.) output shaft. Whilst running under such a load the speed slowly increases and on release from the load the engine speeds up to over 1600 r.p.m., but this cannot be maintained by the heat available. The mean working pressure maintained by the self-driven air pump of 8 mm. (0.31 in.) bore and stroke is between 17 and 25.2 km./sq. m. (2.5 and 3.0 p.s.i.) gauge, and the temperature rise of the cooling water provided by the water



part Section CC

Fig. 3A
part Section DD

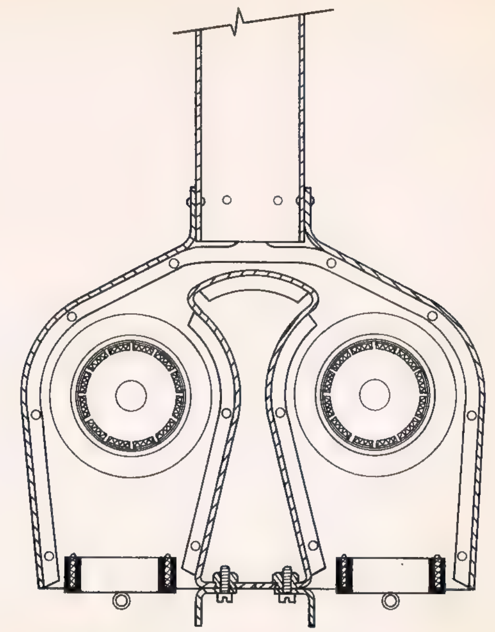


Fig 3c Section AA

pump of 4 mm. (0.156 in.) bore and 8 mm. (0.31 in.) stroke is barely discernible to the hand. The consumption of methylated spirits under the natural draft of the 200 mm. (8 in.) flue is approximately 1.8 grams (0.07 oz.) per minute.

Construction of the engine started over Christ-

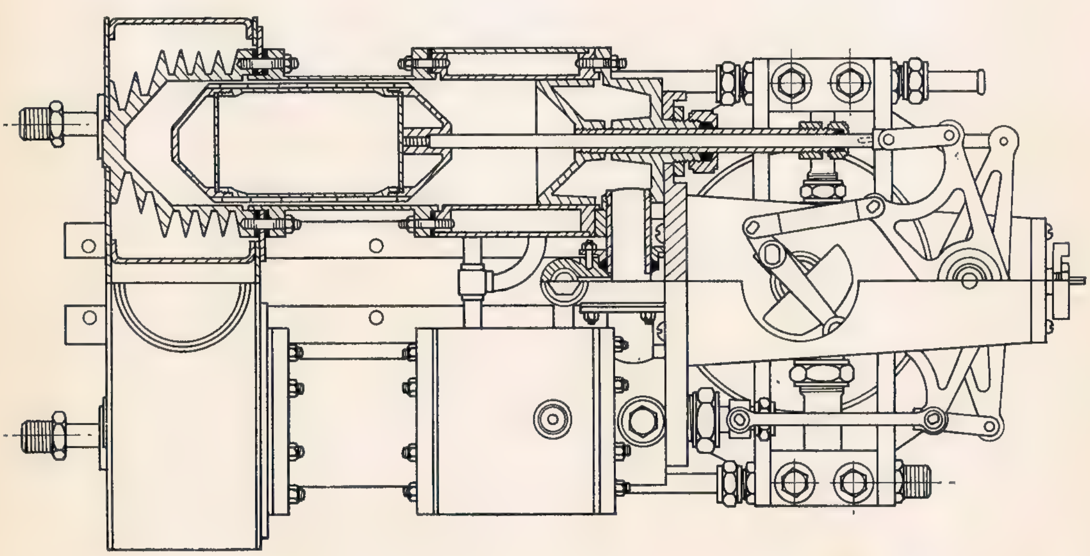


Fig. 3B PLAN & PART SECTION BB

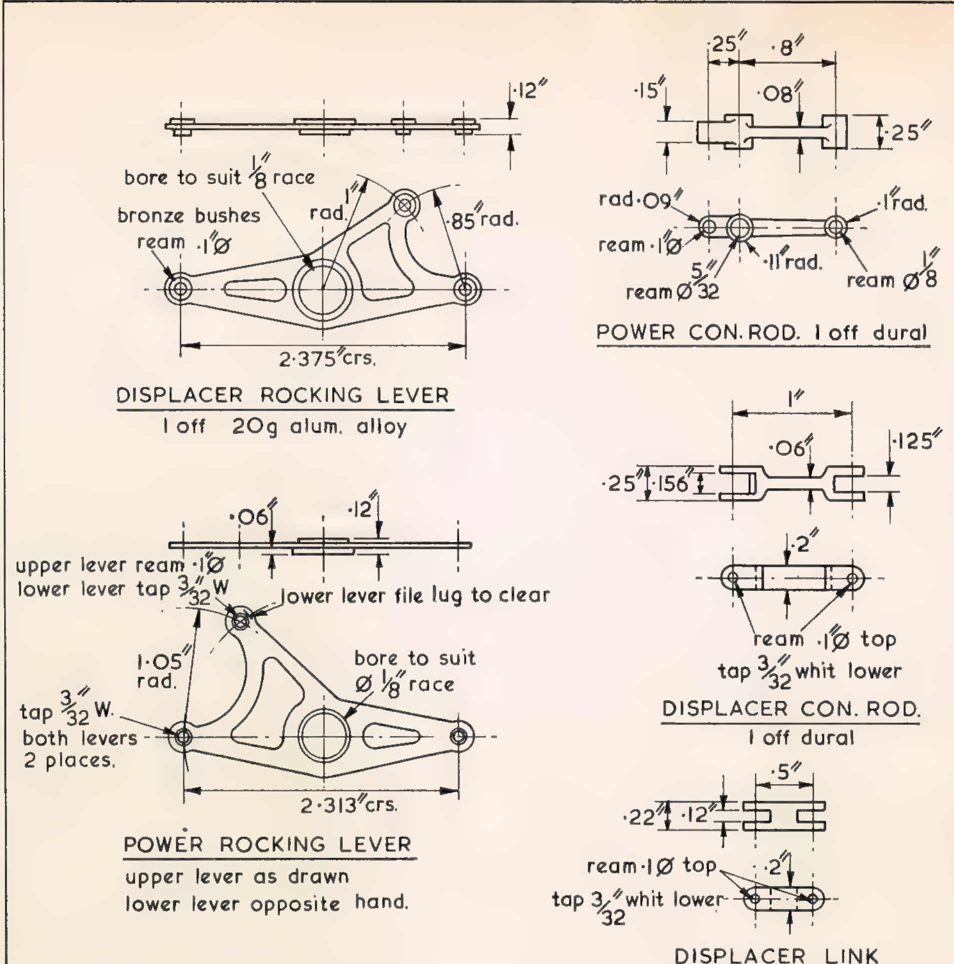
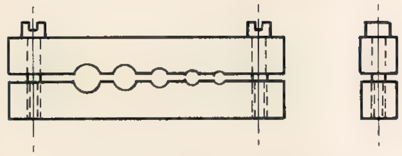


Fig. 4
MECHANISM DETAILS
To suit cylinder centres 2·25″
℄ crankshaft to ℄ rocking levers 1·4″
crank radius ·31″



Size	3/16″	power piston rod crank & output shafts
	5/32″	Crank pin
	1/8″	Little end pin (power)
	No. 32	Displacer piston rod
	1/10″	Link pins Crank pin pump drive

Fig. 5 SHAFT & PIN LAP

mas 1973, after some four months had been spent examining the alternative layouts, particularly of the phase shift mechanism, and in September a machine having the bare essentials of an engine was ready for testing. This nine months is not an indication of the work involved, but only of the slow rate of metal removal on my light home-made 3 in. lathe; machining 25 mm. bores from the solid followed by lapping to remove the residual taper is a slow process. Hopefully the test was to show whether to proceed or go back to the drawing board. As might be expected, there was some encouragement to go ahead, but also some faults to be fixed. For this test and many later ones, each cylinder was pressurised via separate check valves from a small reservoir supplied by a bicycle pump; cooling was thermosyphon through 6 mm. (0.25 in.) bore hoses; the burners ex-steam plant were not

enclosed and were held in place by string and sealing wax (almost) and various self-centring chucks were tried for flywheels.

The engine ran after a long delay, or so it seemed, probably due to the poor heating from the open flames, and responded to pumping, making a horrible clatter shortly after starting. The hot end of a displacer had unscrewed and was hitting the cylinder end. This fault continued to be the most prevalent cause of breakdown over the next six months or so. It is obvious, of course, that the differential expansion of the aluminium cap on the steel barrel is the primary cause. However the use of special spanners and subsequently staking around the threads increased the time between breakdowns and priority was given to completion of the engine rather than remaking these parts which, in steel, would be a most time-consuming process. The fault appears to have been overcome by securing the aluminium ends in place with Pliebond, a synthetic plastic adhesive, PVC base I think, the char of which is tough and somewhat flexible. For nearly twelve months now the engine has been completed and can be used with every confidence of a trouble-free run.

The results of the pressurisation test runs are worth noting, as although somewhat unexpected, given clear thinking they could have been predicted. Without pressurisation the engine runs, no load, at approximately 1200 r.p.m. and if air is then released from the reservoir at about 200 kg./sq. m. (30 p.s.i.) gauge into the cylinders, the engine slows and may stop, no doubt due to the cooling of the hot source by the incoming air. However if the pressure is slowly increased the engine speed increases and as the pressure increases so can the rate of pumping be increased without any adverse effect. It was possible to maintain approximately 60 kg./sq. m. (10 p.s.i.) gauge and at this pressure the engine is lively and pulls strongly under heavy torque loading. The effort required for pumping far exceeds the rewards! With the air lines from the reservoir disconnected at the inlet to the check valves on the cylinders, the ball valves continuously rattle whilst the engine is running, as apparently at each stroke there is an intake of air to replace leakage. Obviously better glands than steam practice are needed. The performance of the engine with the check valves operative is noticeably better than with the valves sealed. It was found that the pressurisation into the buffer space behind the power pistons, using a single check valve, was effective and reduced the cooling effect of sudden pressurisation—so much for my hours of careful lapping of the power cylinders and pistons. In view of the performance improvement obtained with the replenishment of working fluid through a check valve I would like to hear of any tests with such a valve on single cylinder machines.

At one of the later breakdowns due to the loose displacer end cap, it was found that the corrugated aluminium foil wings forming the regenerator had worn into each other giving an accumulated 3 mm. (0.12 in.) of end play to the regenerator core. The coarsely corrugated rings were replaced by a double layer of finer corrugated rings, the layers being separated by a plain ring, so providing a greater area and mass to the regenerator. However the engine performance subsequently had deteriorated, most likely due to the restricted passages causing the transfer flow around the displacer to be mainly in the clearance between the perforated outer sleeve of the regenerator and the cylinder. After stripping this finely corrugated regenerator, the engine was tried without any foil rings but the performance was sluggish and uninspiring. Coarse corrugated foil rings have now been bonded to the displacer body with Pliobond.

The thermosyphon cooling system used in the initial tests employed a 2 litre (0.5 gallon) reservoir with short, rising water lines to and from the water jackets, the reservoir inlet and outlet being 150 mm. (6 in.) apart. When running, the jackets became too hot to touch (40-50°C.) and the thermal stream into the top of the reservoir could be clearly seen indicating circulation was occurring. The syphon was, at times, a reluctant starter, with adverse effects on engine running; further, without some reasonable temperature differences, water circulation would not occur and so with a thermosyphon the temperature of the cold end must be greater than that of the incoming water, i.e. not the lowest that could be obtained. In the ship installation the water jacket outlet would be above waterline and a simple thermosyphon could not work. A reasonable arrangement of water and air pumps, using a common Scotch yoke drive, was fitted, giving a marked reduction in the cold end temperature and an improved engine performance. Restrictor jets are fitted in the water jacket inlets to ensure some sharing of the flow between the two cylinders and to play the cooling water against the cylinder walls at the hot end of the cold space.

The experiments with the size of the flywheel only confirmed that if you want an engine to run evenly at low speed under a heavy load then fit a large flywheel, and if a quiet engine is wanted, mount the flywheel on the crankshaft, not on a geared output shaft; the rattle through the backlash of the gears is most pronounced in the quiet Stirling engine. Using a 5/16 in. Jacobs chuck, starting was more difficult than with a 3.5 in. self-centring lathe chuck, but high-speed running was satisfactory. The heavier chuck allowed good slow running, hence the large flywheel now fitted to the crankshaft.

Experience, over many years, of spirit burners under low boilers in model ships has shown the advantages of very narrow wicks with the combustion air vents in the firebox directly underneath the wicks, the firebox being mounted about 7 mm. (0.3 in.) above the ship's hull on a supporting chassis, in comparison to the usual round wick tube. In the round tubes the vaporised spirit from the centre of the wick does not meet with combustion air until the gases have risen well past the heating surface. The mixed vapour and air is often capable of burning, if ignited, at the top of the flue. The first burners made for the Stirling plant were shallow trays each 25 mm. (1.0 in.) square with four air vents each 8 mm. (0.35 in.) inside diameter through them to supplement the spirit/air perimeter. Asbestos cord was lightly packed into the remaining space and spirit was fed from underneath the tray at three points through a fine needle valve from the spirit tank. As the rate of fuel flow was increased, it was found that the flue gases could be ignited well before there was any sign of liquid flooding from the trays, that is the wick area/air perimeter ratio was too great. The burners now fitted are annulii 25 mm. (1.0 in.) outside diameter, 3 mm. (0.12 in.) wide containing an asbestos wick and fed at two points from the needle valves. An alternative to the needle valve control, preferred for stationary use, is the "chicken feed" system into a feeder well connected to the burners. However these are liable to spill in ship handling and given a responsible attitude from the operator, the needle valve control is satisfactory. The baffle in the firebox forming, in effect, two separate combustion chambers with a common flue is a post-design modification found necessary when the test after fitting the firebox was a complete failure, the flames taking the path of least resistance to the flue, leaving two-thirds of the heating surface ineffective. Once again a predictable fault given enough thought.

To be continued

AN EIGHT-DAY WALL CLOCK

by J. Lowndes

THE CLOCK TO BE DESCRIBED is designed to be a simple, reliable timepiece, with a relatively short pendulum and weight fall. The gear train is chosen to give a pendulum beat of just less than three-quarters of a second and the weight drops three feet in eight days. All the wheels are cut to a pitch of 42 D.P. and epicycloidal form. Since lantern pinions are to be used only one cutter is needed for the whole clock. Home-made fly cutters are used for the escape wheel and ratchets.

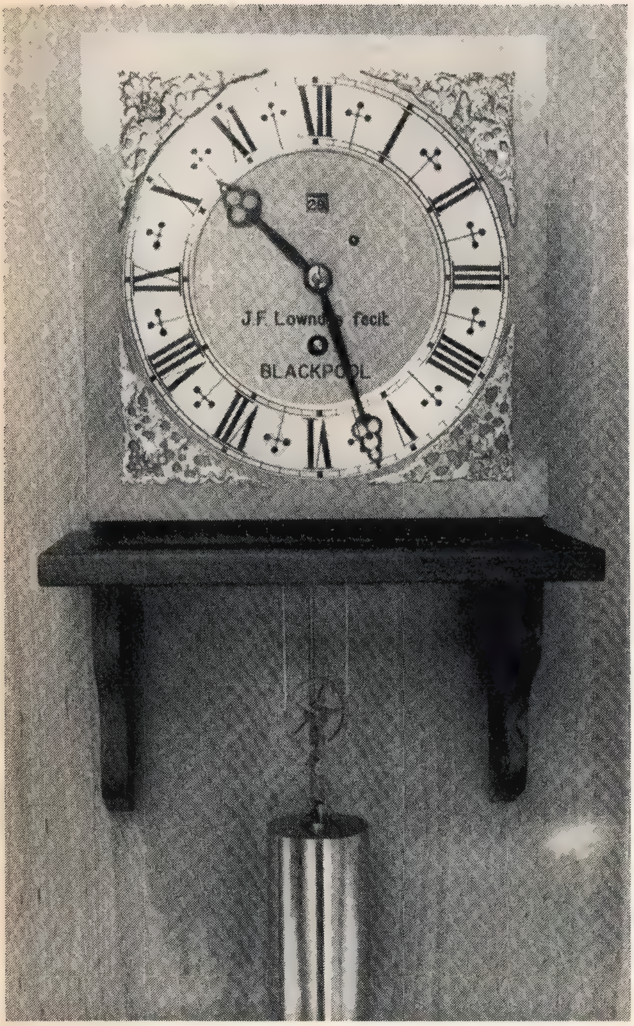
Very few special tools are needed to construct this clock, but I think two broaches, one for cutting and one for polishing the pivot holes, are essentials. These should taper from 1 mm. to 2 mm. and will cost less than 50p for the two. Also highly desirable are a 4 in. crossing file for the wheels, a pivot file to finish the pivots and a 42 D.P. wheel cutter. The pivots can however be polished with emery sticks, the crossings filed in the wheels with needle files and the wheels may be fly cut. Two excellent articles, written by John Stevens, were published in *Model Engineer* three years ago on fly cutting and dividing clock wheels.

Plates and Pillars

The plates are cut from 10 s.w.g. hard compo brass and registered at the points shown with 1 mm. pins. The edges of the plates are then filed square and the holes for the pillars drilled and reamed to 5/16 in. The pillars and washers are turned from ½ in. dia. brass rod, taking care to undercut the flanges so that plates are clamped by the largest diameters. The decorative turning is marked out by taking plunge cuts with a small parting tool, whilst the lathe saddle is locked. After removing the bulk of the metal, a hand tool is used to finish and form the radii. The washers are also formed using the hand tool and after drilling, are undercut and parted off. The pillars and washers may be polished with emery sticks at this stage.

The Barrel

A 1⅛ in. length of 1½ in. O.D. x 12 s.w.g. brass tube is machined to square the ends and to reduce the length to 1 in. Inside burrs are removed with a hand tool. Two 1¾ in. O.D. x 3/16 in. brass blanks are cut for the barrel ends. These are chucked and spigots are machined on them to fit the barrel tube. One is left with a 3/32 in. flange for the driving end and the other with a 3/64 in. flange. Pilot holes are drilled in the centres of both ends ¼ in. dia. The arbor is machined next from 7/16 in. dia. silver steel. This is done between centres and the first operation is to reduce the diameter of the barrel portion to 5/16 in. dia. Two runs of straight knurling are then made to key the barrel flanges. The flanges can now be bored out to a drive fit and the barrel components assembled on the arbor. The assembly is returned to the lathe and three tapping holes for 12 BA are drilled with the drilling spindle at each end into the flanges. These may be indexed from the chuck jaws. The line hole should also be drilled 3/64 in. dia. with the spindle.



After tapping the 12 BA holes, short lengths of studding are used to secure the barrel tube to its ends. Turning between centres is now resumed and the barrel is machined all over. A shallow relief is given to the driving flange. The lathe is then set to screw cut 20 t.p.i. and a thread started from the line hole. When finished, this should be half round in form to accommodate the line. The carrier must now be clamped to the catch plate pin, and the milling spindle mounted on the vertical-slide to cut the driving ratchet. This is fly cut with the cutter positioned to give a slight undercut to the teeth. Fifty teeth are needed and the mandrel is indexed from a change wheel or a division plate mounted at the rear of the lathe.

The arbor may now be finished by turning the pivots and the slip washer groove. The winding square can be filed to shape, using the roller filing rest and mandrel indexing for four positions. The barrel should be polished with emery sticks and pivots made smooth with an oiled pivot file followed by a hard steel burnisher. The centres may be removed now, but it can be advantageous to leave them in for the time being. A hole must be drilled in the driving flange 3/16 in. dia. to meet the line hole so that the line can be knotted inside the barrel.

Wheel Cutting

A $2\frac{5}{8}$ in. dia. x 5/32 in. blank and a $2\frac{3}{8}$ in. x 1/16 in. blank are both bored to a running fit on the barrel arbor. A mild steel mandrel is turned in the 3-jaw chuck for the rest of the machining. The thicker blank is turned to $2\frac{1}{2}$ in. O.D. and whilst mounted on the mandrel 100 teeth are milled into its periphery using the wheel cutter mounted on the milling spindle. Before removing, a 5/64 in. deep recess is machined for the maintaining spring. The four crossings are also marked out with the scribing block before the wheel is removed. The maintaining ratchet is fly cut on the same mandrel with 100 teeth and marked similarly for the crossings.

The other wheels are cut and marked in the same way. All three 72-tooth wheels are cut together on a mandrel and so are the two minute wheels with 39 teeth. The escape wheel is cut using a silver steel fly cutter to the form shown in the drawings.

I indexed all the wheel cutting operations and crossing markings from a home-made division plate made by the punched tape method. The milling spindle is also home-made and is driven at 4,000 rev./min. by a $\frac{1}{6}$ h.p. motor mounted on the cross-slide. All the wheels can be cut at one pass and the cut is adjusted with the vertical-slide to leave minute witnesses at the tips of the teeth.

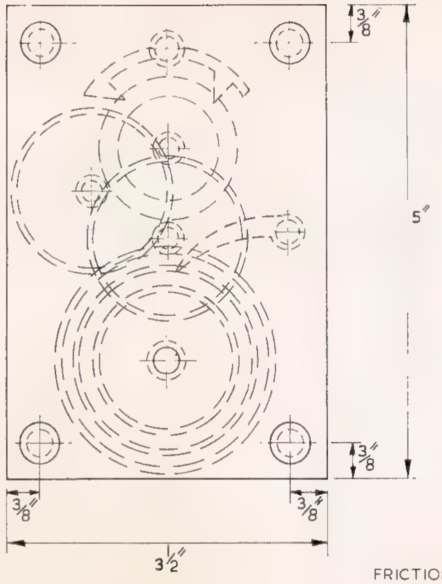
Wheel Crossings

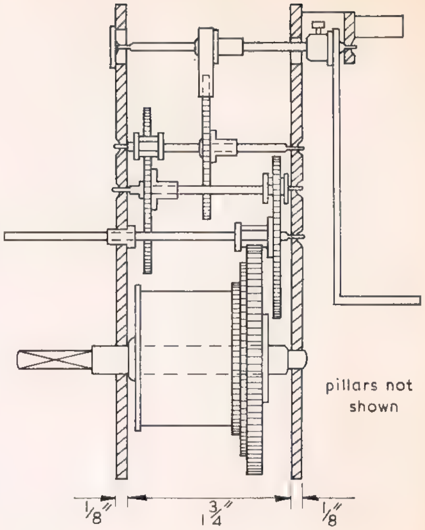
The metal to be removed is cut out with a medium Abrafile and the crossings are filed to the dimensions given. After finishing with a fine crossing file and needle files the crossings are burnished with a steel knitting needle. Burrs are removed by rubbing the wheel on "0" emery paper on a flat surface and the wheels are polished with "000" paper. Remember, clock wheel crossings should be light to reduce the weight of the wheel as much as possible and the corners should be square.

Maintaining Power

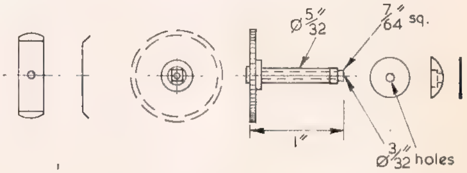
Silver steel pins threaded 10 BA are fitted to the great wheel and ratchet at the points indicated. The maintaining spring is made from 1/16 in. dia. silver steel bent hot and hardened and tempered to just below blue. A mild steel click and hard brass spring are fitted to the maintaining ratchet wheel to engage with the barrel ratchet.

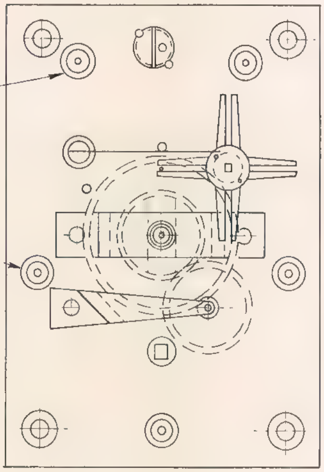
The spring is screwed and pinned. After assembling all the components on the barrel arbor an

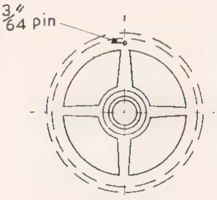




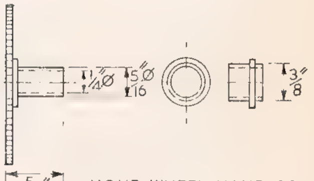
FRICTION SPRING, MINUTE WHEEL, HAND COLLET & PIN



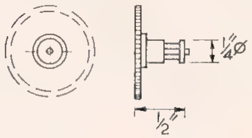




HOUR WHEEL



HOUR WHEEL HAND COLLET



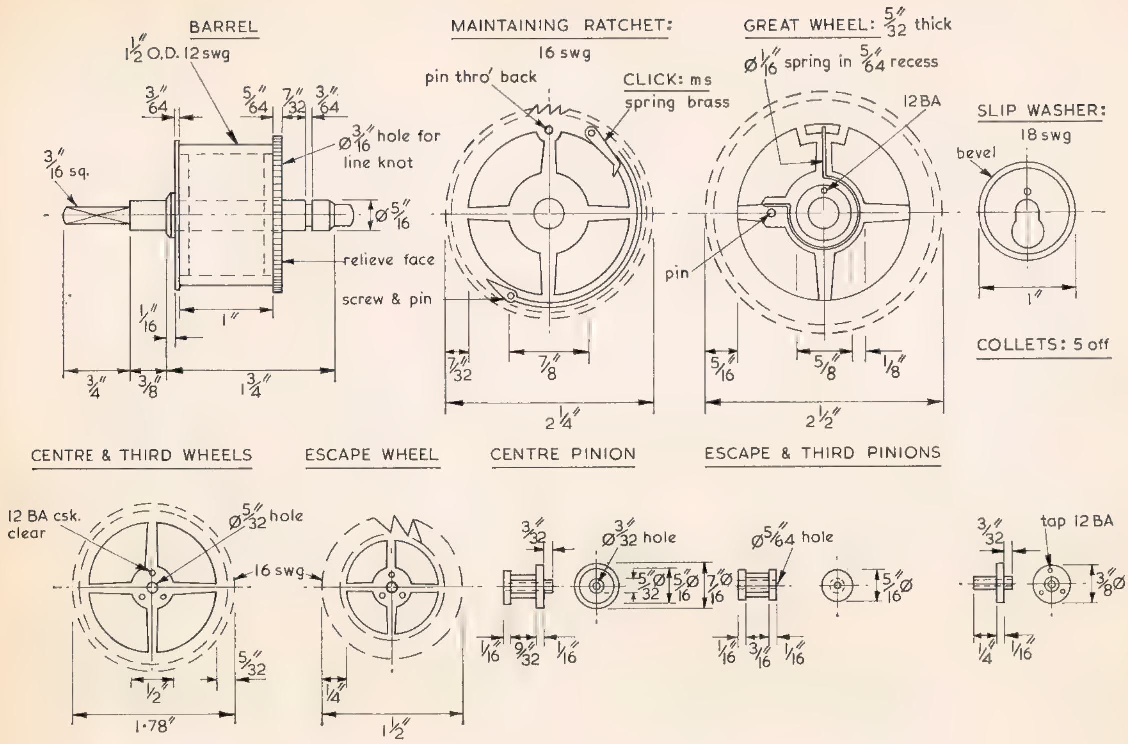
REVERSE MINUTE WHEEL & PINION

18 s.w.g. brass slip washer is made to retain the great wheel. This is secured to the great wheel with a 12 BA screw. A maintaining pawl is made from an annealed hacksaw blade and hardened and re-tempered to blue. This is colleted, mounted on an arbor like the wheels and positioned to engage with the maintaining ratchet.

If you do not wish to fit maintaining power, fit a pawl and spring to the great wheel so that it is driven directly from the barrel ratchet. The few seconds lost during winding will not be missed, but you must remember to stop the clock before winding or risk damage to the escape wheel.

Wheel Collets

The wheel collets are turned from ⅜ in. dia. brass rod and drilled to suit the arbors to be used. It is usually best to drill first one size smaller than required and then follow with the correct drill size. This gives a close-fitting collet. Before parting off, the wheels are fitted and the three 12 BA tapping holes are drilled using the drilling spindle. The holes in the collets are tapped and those in the wheel opened to clearance and countersunk. The collet may now be parted off and the wheel screwed in place. Similar collets are made for the crutch, anchor and maintaining pawl.



Pinions

Lantern pinions are used in this clock and are turned from 5/16 in. dia. brass rod. The eight pin holes are pitched on a 0.19 in. dia. circle. This dimension can be set accurately if a pip is left in the centre of the pinion by withdrawing the spindle mounted drill from the pip to the required radius using the cross-slide thimble. The pin holes are 1/32 in. dia. and it will be found that 0.032 in. dia. sewing needles are a good drive fit in them. Surplus needle can be cut off, ground flush and the whole pinion end polished with emery sticks. Whilst still in the lathe the centre hole must be drilled to suit the arbor it is to fit.

The Arbors

Silver steel is used for the arbors, 3/32 in. for the centre and 5/64 in. for those higher up the train. The pivots must be concentric with the arbors, so use collets for chucking or a true running bush in the 3-jaw, unless you know your chuck is really accurate. Turn the pivots to diameter, smooth with the pivot file well oiled and bevel the shoulders. Remove from the lathe, harden and temper to blue and then return to the lathe for a final polish. The arbors should have a little end play when fitted; 0.01 in. is about right.

The pinions and wheels are depthed before being fixed to the arbors. My depthing tool is a slotted piece of 1 in. x $\frac{1}{8}$ in. mild steel which takes a variety of runners at variable centres. The wheels are adjusted to run correctly with the pinions on the runners and the dimension between centres are transferred to the plates using the points of the runners like dividers. The centre arbor must be positioned $\frac{1}{8}$ in. above the centre of the plates if the great wheel is not to project below the plates. When all the positions have been marked, the plates are registered and drilled undersize for the pivots.

The Anchor

I used an old file to make the anchor. This was annealed and ground smooth. Gauge plate on mild steel (case hardened afterwards) are also suitable materials. After fitting the collet in the correct position on the blank, the marking out is done from the escape wheel with both items mounted at 1 1/16 in. centres in the depthing tool. It helps here to use runners with female centres for the divider points and to coat the blank with marking blue. After marking as per drawing, the anchor is sawn and filed to shape. Careful filing then follows with frequent checks in the depthing tool until the anchor will just pass the escape wheel teeth. The depth tool centres are then transferred to the plates. The anchor is given a meticulous polishing and hardened but is not tempered.

To be continued

STEAM TOY MAKER OF DEREHAM

by Basil Harley

WHEN COLLECTORS of early toys turn their attention to those exciting examples driven by methylated spirit and live steam, it is not long before they come upon the products of Bowman Models Ltd. At first glance these solid examples of British engineering seem perhaps a trifle dull compared to the colourful tinplate wares that poured from the German factories of makers such as Bing and Marklin. Their very massiveness and simplicity, however, is an expression of their other great virtue, that they all worked supremely well and it was in part for this that they were cherished and cared for. And, of course, they lasted well enough to come down to us in significant numbers some 40 or 50 years after they were made.

Bowman Models as a company lasted little over 10 years from about 1923 to 1934. It was established and run by Mr. Geoffrey Bowman Jenkins of Dereham in Norfolk. Mr. Jenkins, who was born in 1891, was an ingenious and inventive man and his first patent concerned a toy locomotive. This was granted in 1919 (Patent No. 123464) and covered a means of driving a toy railway engine by elastic. His second patent (No. 208319) related to "Improvements in Toy Steam Boats and the like" and was granted in 1923. At the time of the application he was making toy boats in London near Clapham Junction. As a result of his success and with the patent in his pocket, so to speak, he was invited to Norfolk to discuss a joint venture.

Hobbies Ltd. had been going since 1897 and was well established in the fretwork and amateur woodworking business. They had for instance their own foundry and well-equipped machine shops for making the fretsaws and other tools they sold. They were the obvious people to make the wooden hulls and Mr. Jenkins, as Bowman Models, would make the engines. This he did in premises by the railway station rented to him by Hobbies. At first about a dozen men were employed but this soon trebled as business developed.

The patent had established the form of almost all the English toy steam launches in the 1920s and 1930s. "Toy" rather than "model" since they and indeed all Bowman products made no pretence of being anything approaching scale models and were sold primarily for children. The launches were totally different in appearance to any of the elaborate German tinplate boats; they had wooden hulls and much more powerful engines. In their simple clean lines they looked very much like pre-1914 racing launches with a high length-to-beam ratio, sloping counter and turtleback spray hood. Fig. 1 shows one of the patent drawings and Fig. 2 a recently discovered example, in a somewhat distressed condition, of one of the earliest launches made to the published specification. The simple engine is partly made of wood!

It was not, however, a very strong patent and soon a number of other manufacturers had paid them the compliment of making very close copies. The Hobbies-Bowman range soon extended to four, birds of somewhat dissimilar feather, *Swallow* (20 in. long), *Snipe* (23 in. long), *Eagle* and *Seahawk* (both 28 in. long). All were powered by single acting oscillating cylinder engines (*Seahawk* was twin-cylindered) with ample boiler capacity and windproof casings and lamps. They were tested, the prototypes only I suspect, on a large water tank on the Hobbies premises. The late Mr. R. Pratt, one-time chairman of Hobbies Ltd., recollected at least one early model exploding dramatically in the middle of a test run!

Boats such as these (as well as *Miss America, Peggy* and a simple steam tug) became very popular in the late 1920s and the *Meccano Magazine* and the *Boy's Own Paper* carried numerous advertisements for them. Few were as exciting as the one for the Bowman *Snipe*. One, perhaps it was this very one, was so effective that it resulted in an enquiry, from Lagos Mr. Pratt thought it was, as to how far it will travel in the open sea and how many adult passengers will it carry! A boys' hobby annual published elaborate (but incomplete) instructions for making your own, flagrantly copying the Bowman design. The article started —"Model power boats are rather expensive things to buy, but it is not at all difficult to make one . . . ". Bowman's ranged from 17s. 6d. to 42s., trifling by today's standards.

It was not long before the range of products was extended to include stationary engines and locomotives. These were not all made jointly with Hobbies Ltd. but some were sold under Bowman Models' own name, others under Hobbies' name and yet others by other members of the trade. For instance, in 1927 Warboys and Smart of Dereham were advertising engines "made under Jenkins patents" and, I strongly suspect, in Bowman work-

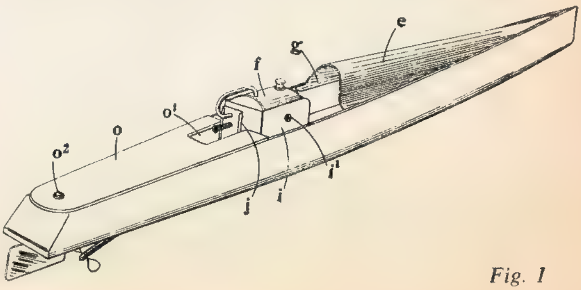


Fig. 1

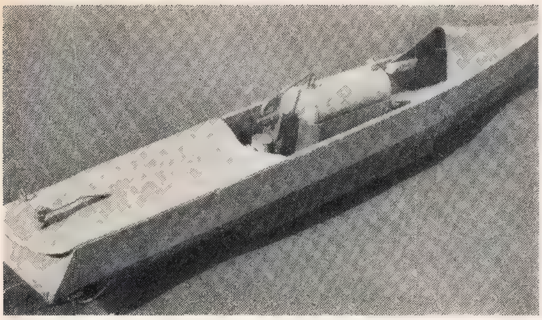


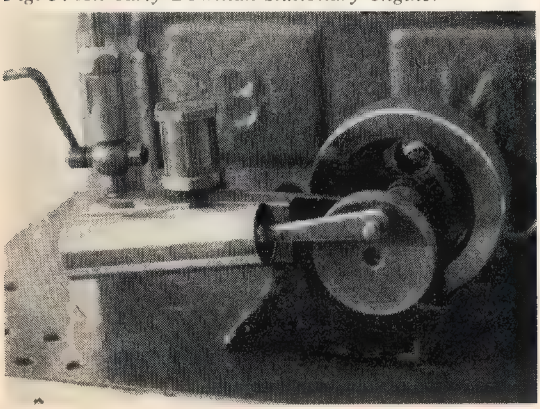
Fig. 2: A recently-discovered launch made to the patent specification over 50 years ago.

shops. All the stationary engines were horizontal ones—no vertical engines were ever made—and the single acting oscillating cylinder engine was used exclusively. In the larger models the cylinders were cunningly disguised with fixed polished brass covers making the engines look not unlike gas engines.

At this time, the popularity of Meccano was at its height. Clockwork and electric motors were supplied by the company but it turned its face against marketing steam engines until 1929. Here was an opportunity that Bowman Jenkins seized. He drilled the metal bases with 5/32 in. dia. holes on $\frac{1}{2}$ in. centres so that the engines could be incorporated directly into Meccano models. At first only the corners of the bases were drilled, in two rows, but later they were drilled all round. The advertisements made much of this and also the fact that they were drilled "by kind permission of Meccano Ltd." though there must be a doubt about any proprietary right they had in a series of holes spaced $\frac{1}{2}$ in. apart. Fig. 3 shows an early example with the letters B and M embossed on the boiler casing and before Bowman fitted the brass cylinder covers.

Big boilers, big lamps and well-fitting pistons and valve faces were important characteristics of the

Fig. 3: An early Bowman stationary engine.



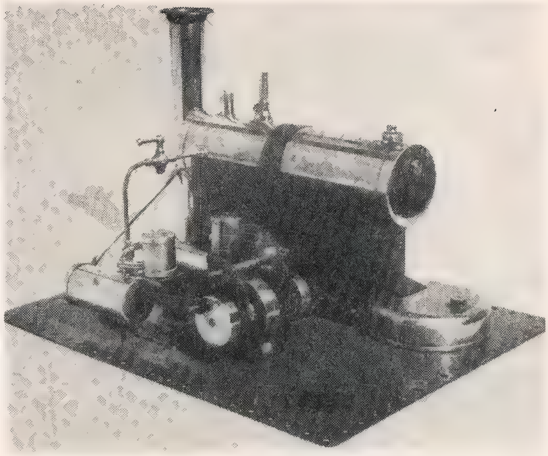
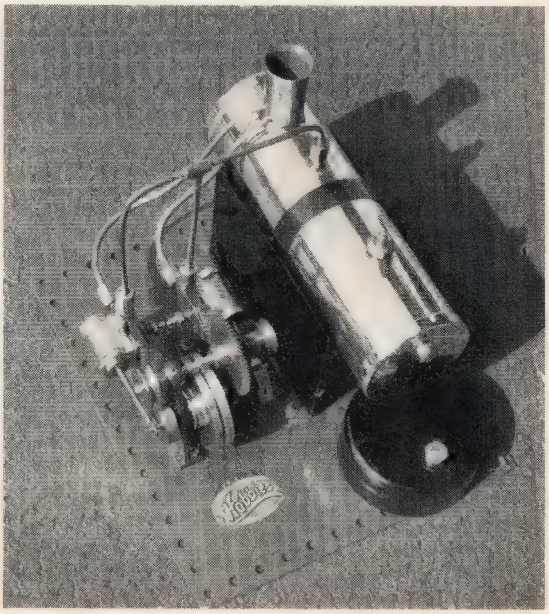


Fig. 4: A Bowman engine of about 1928.

Bowman engines. They worked, they worked well and long and they were powerful for their size. The 1927 catalogue said, "In introducing Bowman model steam engines for driving Meccano, Erector and other models we are opening a new era to the young embryo engineer. There is no pastime so interesting and beneficial to the would-be engineers as the making of models, but however successful his models may be, a tremendous amount of satisfaction and instruction is lost if he cannot drive them in exactly the same way as real machines. Many makers of really splendid models had never had the supreme joy of seeing them running under actual working conditions. In order to obtain the utmost realism steam power was obviously re-

Fig. 5: Twin-cylinder engine by Malins.



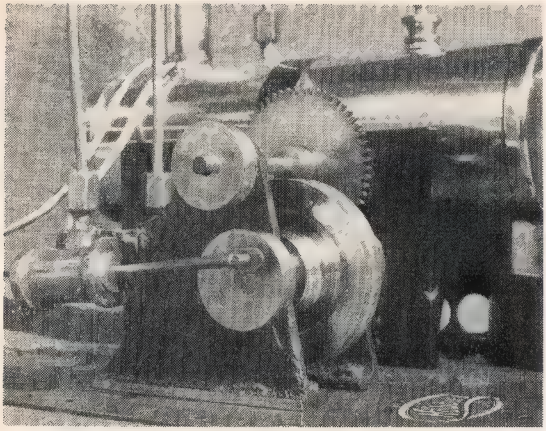


Fig. 6: Engine made by Malins in 1935.

quired but the foreign engines available were hopelessly underpowered and unreliable."

It was also realised that lubrication was vital to the efficiency of small engines. First there had to be the right oil and second there had to be drip feed lubricators and felt oil retaining pads. All these differentiated Bowman Jenkins' engines from the German ones he so despised. "Every model herein listed, even the very cheapest, is something very different from the accepted Continental production. Instead of fragile stampings sweated together, lead pistons and bright colour, nothing but the best British raw materials are used and British labour is employed throughout. All parts are accurately machined and screwed or bolted together. Pistons and cylinders of special metals are lapped to a dead fit and the valve faces are accurately ground to give perfectly steam-tight joints. The result is that Bowman Models are *real* models and incomparably better in their marvellous performance and lasting qualities." It was all true too!

Lastly, remembering perhaps the occasional boiler explosion on the test tank, great care was taken in the design of the safety valves which were by far the best of any fitted to toy steam engines.

The engines themselves ranged from tiny single cylinder toys to quite sizeable twin-cylindered engines with geared countershafts and massive boilers (Fig. 4). Such would run for over an hour on one filling and the biggest would "lift 112 lb." or drive a sewing machine. By 1927 it was claimed that over 200,000 engines had been sold. Later a range of workshop toys was produced for them to drive, again with drilled bases so that, for example, Meccano parts could be used for the framework and overhead shafting with the saws, drills and grinders bolted directly in position. A generator, that indispensible steam engine accessory, was also provided, given 4/6 volts at engine speeds up to 2000 r.p.m.

The addition of locomotives to the catalogue signalled a break with tradition, very characteristic of the man, once again designed to serve the purpose of sound engineering, powerful engines and safe working.

By the 1920s, the pre-war large rail gauges of Nos. 3 and 2 had ceased to be commercially viable and even gauge 1 was rapidly declining in popularity. Gauge 0 was the favourite but was soon to be challenged by gauge 00 which was far too small for commercial live steam locomotives.

The Bowman engines were made to run on gauge 0 track — tinplate or the more expensive forms of permanent way—but were built to gauge 1 size in every other respect. Here then was a sizeable pot boiler, big (oscillating) cylinders and a lamp containing enough methylated spirit for three-quarters of an hour's run. To match the locomotives, overscale coaches and wagons were made —the coaches with heavy bogies, wooden bases and ends with lithographed tinplate sides and roofs. All doors opened and the ingenious could easily remove the roofs and equip the interiors with appropriate seating, glazing, etc. Despite the Bowman protestations about appearance in his catalogue the locomotives were poor representatives of any real-life prototypes but they worked like real ones, they sounded quite like real ones and for those fortunate enough to possess one today, will still run very satisfactorily—if you can find a gauge 0 track!

The early 1930s were difficult years for luxury trades and world crises and the slump following the earlier Wall Street crash had made the business of toymaking a somewhat risky one. The famous Bing works in Nuremberg, described as the biggest toymaking firm in the world, went bankrupt. Bowman Jenkins tackled the problem from his point of view in two ways. From the toymaking aspect he diversified, adding for instance chemistry sets, aeroplanes, watermotors and induction coils to his range. He also introduced Aeroboats, long thin speedboats equipped with slender cylinders containing, not compressed air as is often thought (and maybe as he intended it to be thought) but elastic. This was a return to his earlier rubber-driven locomotive patent. Although they had some attractions since the owner could decide to have long slow runs or short fast ones depending upon how many strands of elastic be fitted, the Aeroboats did not last long. The advertisements at this time have a slight air of desperation about them.

Simultaneously he turned to the woodworking business in partnership with Capt. B. A. Smart who had some five years before, with Mr. Warboys, sold Bowman engines. Here, combining the names of Jenkins and Antique, he established the reproduction furniture company of Jentique Ltd. which is still flourishing in Dereham. The patent

register is interesting for this period reflecting as it does his wide ranging ingenuity. It includes successful applications for tables, stools, fittings for drop-leaf tables, means of winding up mechanical toys, a razor stropping apparatus and means for brushing teeth.

Perhaps due to other interests, Bowman Models Ltd. had ceased to function by 1935, but Hobbies Ltd., who had a number of retail outlets in provincial cities, were still interested in selling toy steam engines. One of their Black Country suppliers of metal fittings, the late Mr. G. H. Malins, was asked if he would make some engines for them. A very early one of these, made about 1935 and still in the possession of Malins (Engineers) Ltd., is shown in Fig. 5 and Fig. 6. It has two heavy cast brass oscillating cylinders mounted on a cast frame and a fully drilled flat base plate of mild steel. The geared countershaft follows closely the Bowman tradition. Thus it was that Hobbies Ltd. were the exclusive distributors during their first year of what was to become the present very successful Mamod range of toy steam engines.

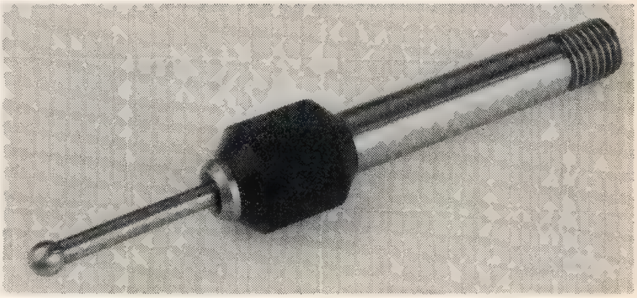
Some time before the Second World War, Mr. Jenkins had relinquished his association with Jentique Ltd. and, living now in Ridlington in Norfolk, continued for a number of years in other businesses unrelated to steam-driven toys. He died early in 1959 having been responsible during a comparatively short period of his life for giving an immense amount of pleasure and encouragement to countless budding engineers, myself included.

AROUND THE TRADE

New Centre Locator

Planet Manufacturing, of 145 Hoppers Road, London N21 3LP, are producing a very useful Centre Locator. This tool provides a simple means of lining up a machine spindle with the workpiece which is to be machined, and its primary use is on vertical milling machines. The $\frac{3}{8}$ in. dia. screwed shank of the locator fits directly into a collet or a conveniently drilled chuck.

The probe end is hardened and there is a choice of two styles to suit different types of workpiece. Simple instructions are included with each locator.



H. Clarkson & Son

From page 1287

With such stories to tell of equipment there is naturally a tale to tell of the building itself, when progress was a bit slow and the proprietor worked through an unceasing weekend. This weekend started on Friday about 5 p.m. when a load of cast iron sleeves arrived for turning and boring. They were all required for Monday, staff refused to work all weekend at short notice, so he set about the job himself (his son was away ill), to the indignation of the workforce on the Monday morning!

Plant models, site layouts, plans of proposed harbour working, fairly secret instructional work for atomic developments have all emanated from Clarksons at York, the greater part of them the brain children of father and son. There must be something of the firm's work in nearly every corner of the world, either on display as a working model in a museum, performing gallantly on some distant miniature railway or gracing a boardroom table. The founder is now in the process of easing out of the managing chair to make way for Herbert Clarkson, his son, who in turn has come up the professional way through an apprenticeship as an optical and scientific instrument maker. Happily his National Service was mainly at Lydd and he became bitten with the steam bug making the most of his time off to spend it with the Romney Hythe and Dymchurch Railway, and was finally employed by R.E.M.E. as an official model maker.

His son was taught soft soldering on the kitchen table at the age of about 12, when one night he electrified the atmosphere by placing a very hot soldering iron on his father's bare forearm!

NEW BOOKS

"Les Locomotives à vapeur de la S.N.C.F. Region Est." by J. Gillot

Published by Editions Picador, CH-5234, Villingen AG, Switzerland.

383 pp.

French readers will welcome this very complete account of the steam locomotives of one of the most important French railways. There is a foreword by M. Andre Chapelon. R.M.E.

The Gauge I Model Railway Association have produced a new and enlarged edition of their book "The Project". This contains full instructions on how to build a simple Gauge I 0-6-0 steam locomotive.

Non-members of the Association may obtain this book for £1.17 from the Gauge I M.R.A., 112 Clarendon Road, Broadstone, Dorset.

"KING'S OWN" — A 5 in. gauge REBUILT SCOT

by Martin Evans

SEVERAL followers of these notes have asked for further details of a 5 in. gauge "Rebuilt Royal Scot", using the chassis of *Royal Engineer*; in fact it looks as if this variation of the L.M.S. 4-6-0s will prove more popular than either *Fury* or *Royal Engineer*, so here are some further details, notably of the smokebox and reversing gear. At the same time, I have drawn out a general arrangement of the engine, which I am now naming *King's Own*, No. 46161. This particular full-size engine was built in 1930, was rebuilt in 1946 and finally withdrawn in 1962. She was stationed at Holyhead in 1950 and ended her days at Holbeck.

The taper-barrel boiler for *King's Own* was described in the 7 November 1975 issue, and it should fit the *Fury* or *Royal Engineer* chassis without any trouble. The smokebox, however, is quite different, being of the drum type, and somewhat smaller in diameter than that on the other two engines. The drum type, incidentally, is easier to deal with, being nothing more than a $7\frac{1}{8}$ in. length of 6 in. dia. brass tube, $\frac{1}{8}$ in. thick. With any luck, it will "telescope" over the barrel tube, with an overlap of 9/16 in., but as the latter will be soft after brazing operations, it should not be difficult to open the end out very slightly, or reduce its diameter, as required, to get a good fit.

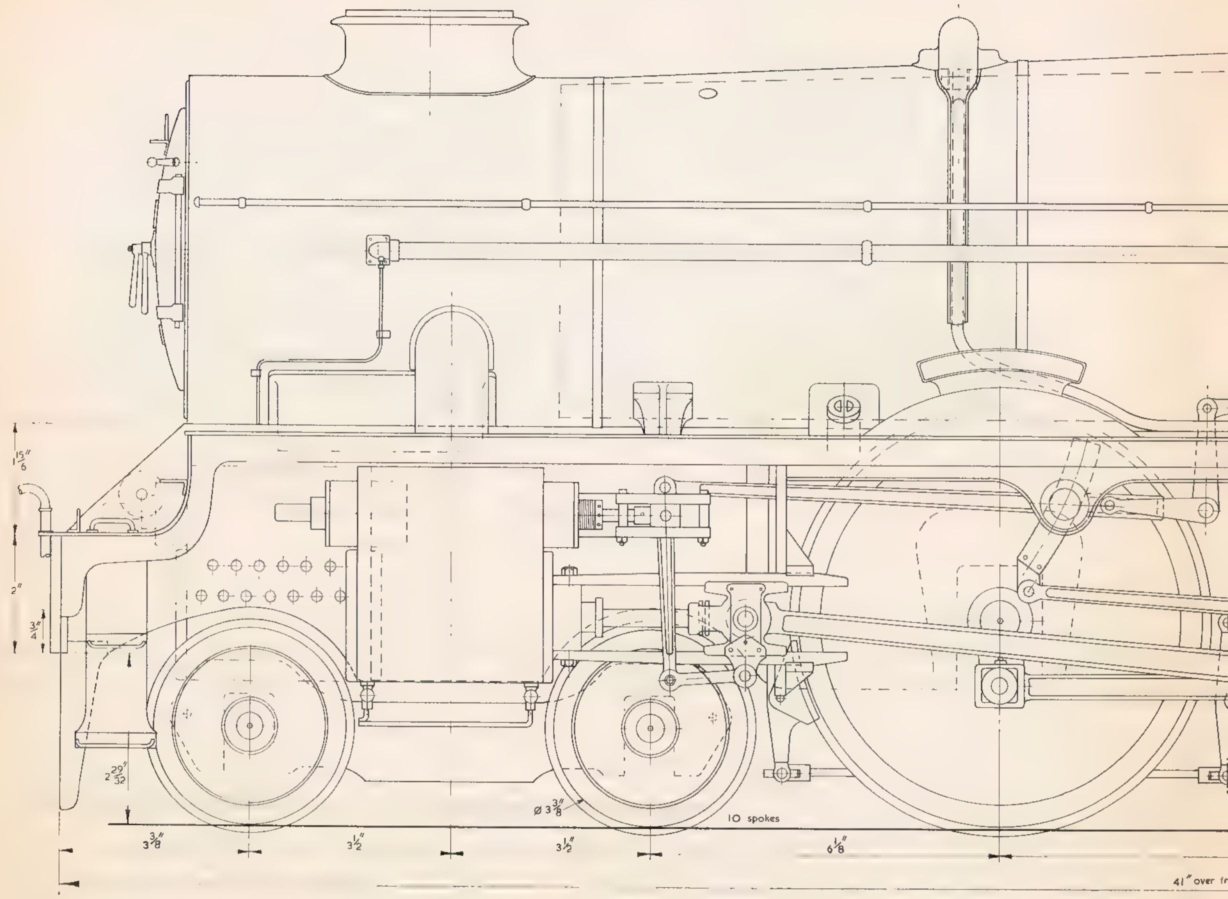
Making the double blast pipe, utilising the existing exhaust pipes from the outside cylinders, with the connection from the inside cylinder, might prove a little difficult, but I think the easiest way to tackle it is to use a short length of rectangular bar, gunmetal for preference, the bottom of this being faced off and bored, then plugged, while the top is angled off to suit the two blast pipes, which are both made from $\frac{1}{2}$ in. x 16 s.w.g. copper tube. (This is easier to bend than thinner tube.) The top ends of the blast pipes are threaded $\frac{1}{2}$ in. x 32 t., while the caps are bored $\frac{1}{4}$ in. dia. Each cap is provided with a blower jet, the two jets being coupled up "in parallel". The blast pipe caps cannot of course be turned to the conical shape shown, but they can be filed by hand, leaving enough metal on the right-hand side to take a $\frac{1}{4}$ in. x 40 t. union for $\frac{1}{8}$ in. dia. pipes. The two pipes from the blowers are led into one of 5/32 in. dia. via a simple Y piece.

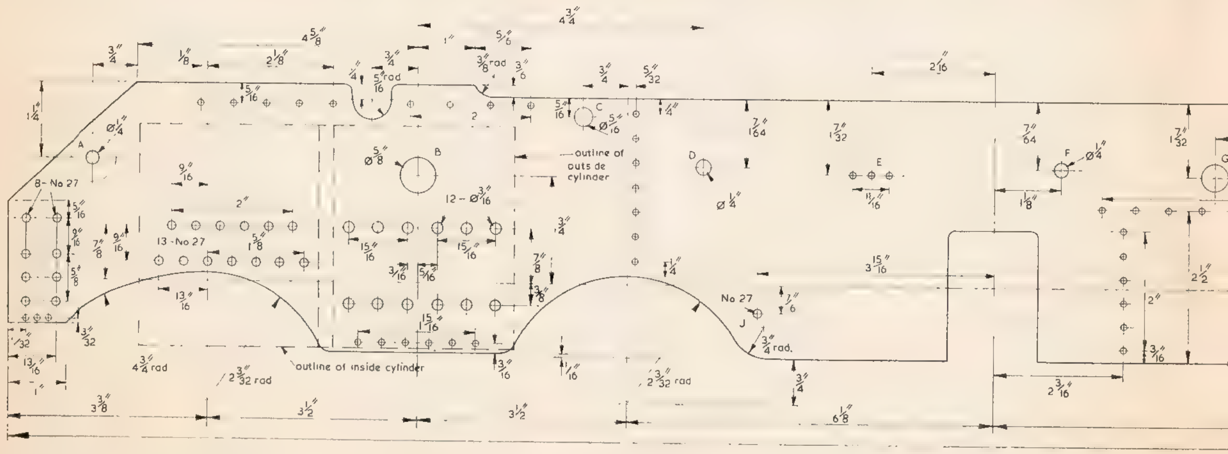
The other items in the smokebox are as for *Royal Engineer*, though the door is quite different, having the simple centre fixing by "dart". My drawing shows the details on the front of the door and on the front ring, which can be turned from a casting, or a ring can be made from square brass bent into a circle and the ends silver soldered.

When the "Scots" were first rebuilt, they were not fitted with smoke deflectors, so my general arrangement drawing shows the engine without these somewhat ungainly fittings; but some builders may like them, so I am showing a separate drawing giving their essential dimensions.

They can be held to the running boards with short pieces of $\frac{1}{4}$ in. angle, and a further support is arranged by the fitting of brackets bolted to the side of the smokebox.

The reach rod of *King's Own* is quite different to that on *Fury* or *Royal Engineer*, as it runs straight from the reversing arm on the weighshaft to the nut on the cab reverser, the stand of the reverser being set rather lower than usual. Additional support is given to the reach rod by the "standard" bolted to the running board at approxi-



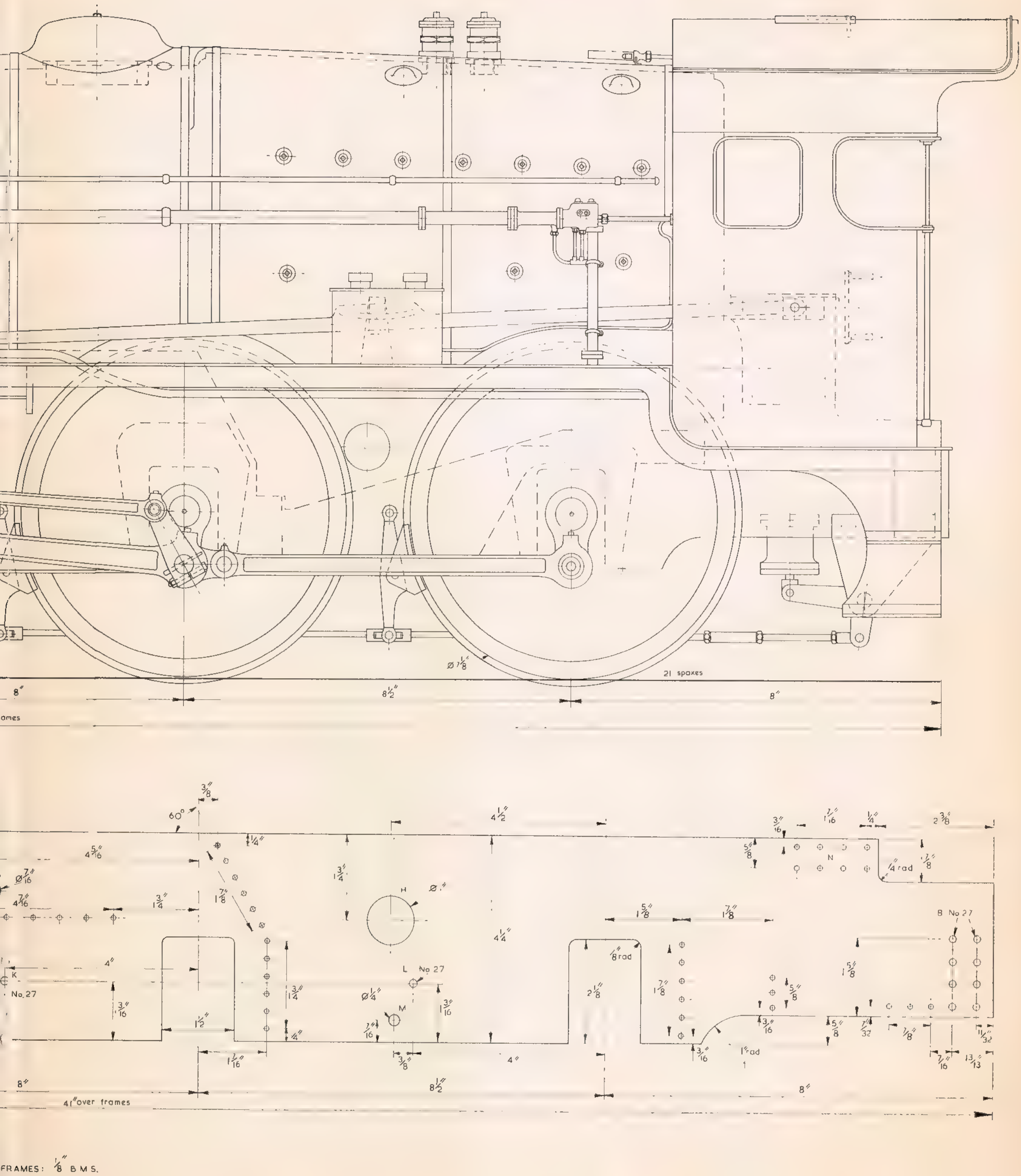


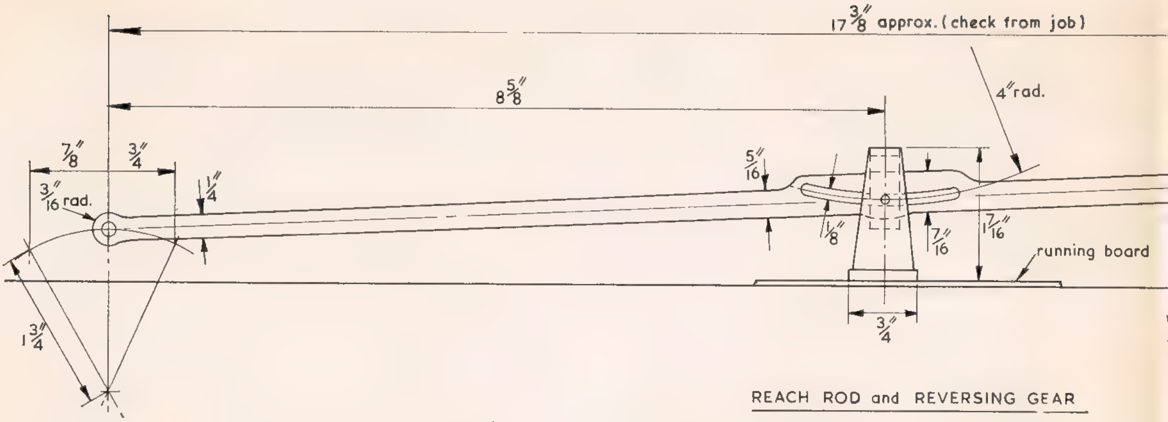
ALL HOLES No.34 UNLESS OTHERWISE STATED

HOLE CODE

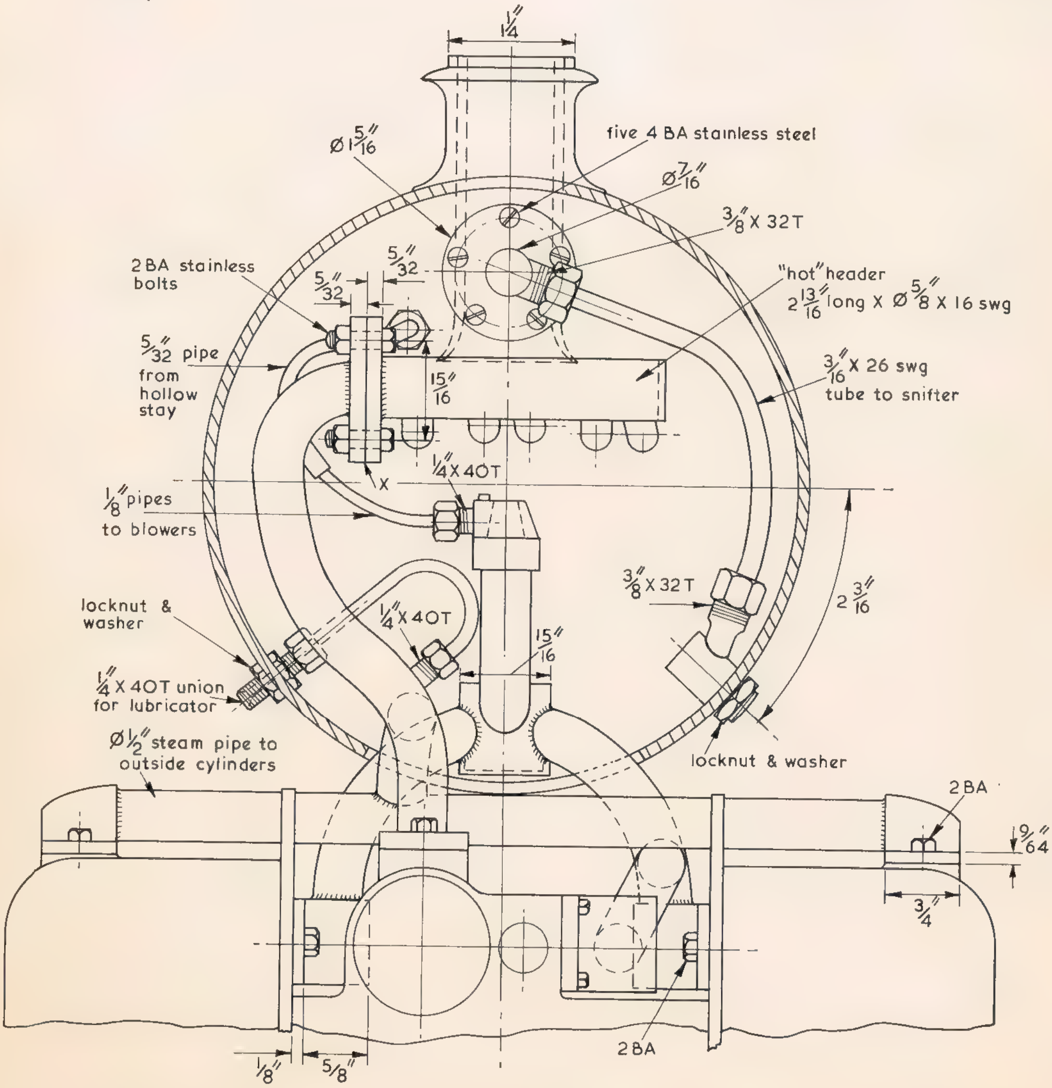
A Lifting hole
B Exhaust from outside cylinders
C Shaft for drain cock gear
D Lining-up hole — inside valve gear
E Location of inside weighshaft.
F Lining-up hole – outside valve gear.
G Outside gear weighshaft.
H Clearance for blowdown valve
J Leading brake hanger pivot
K Driving brake hanger pivot
L Trailing brake hanger pivot
M Ashpan dumping pin hole
N Group of holes for reverser (left hand side only)

MAIN

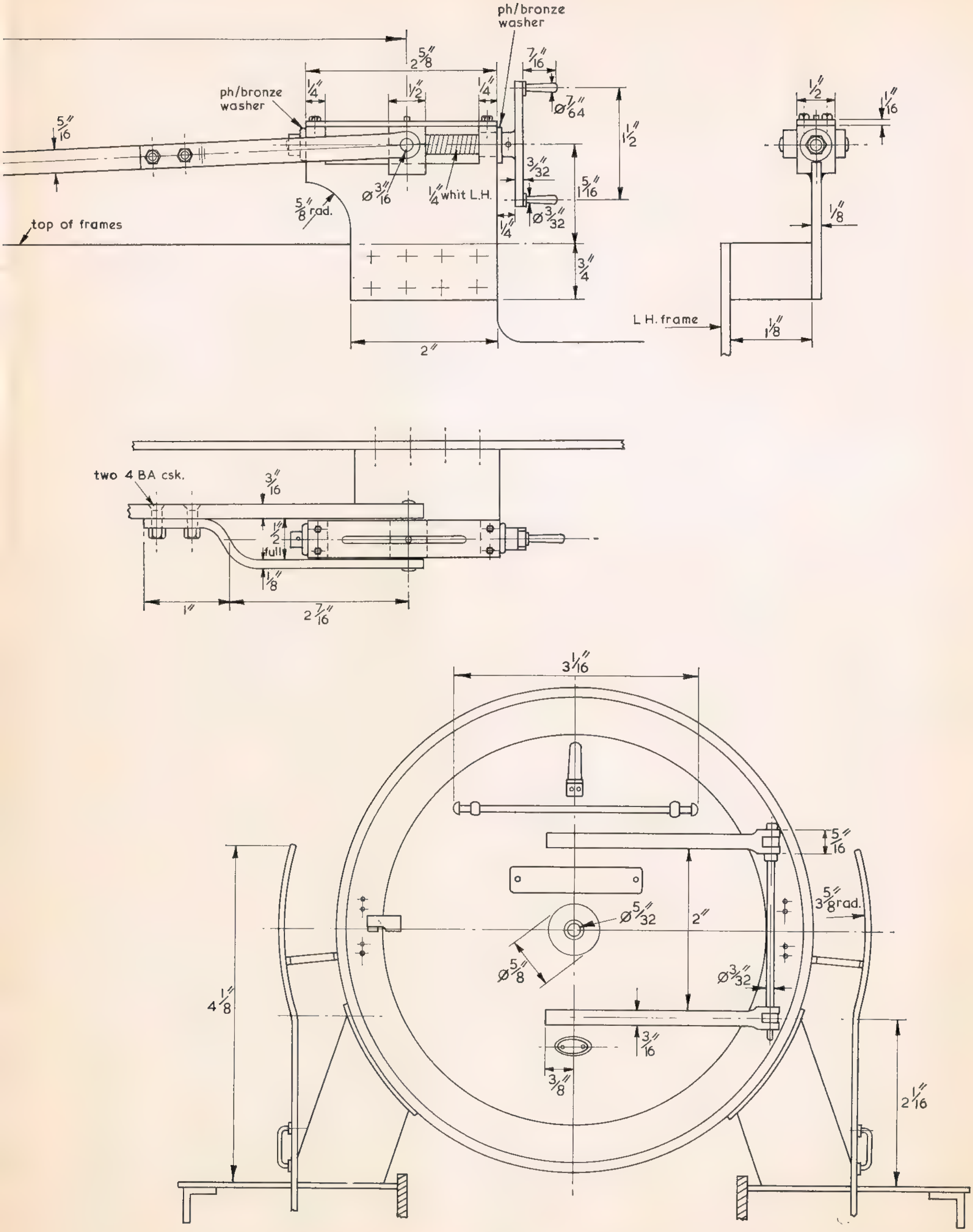

21 spokes
41" over frames
L No 27
B No 27
FRAMES: 1/8" B.M.S.



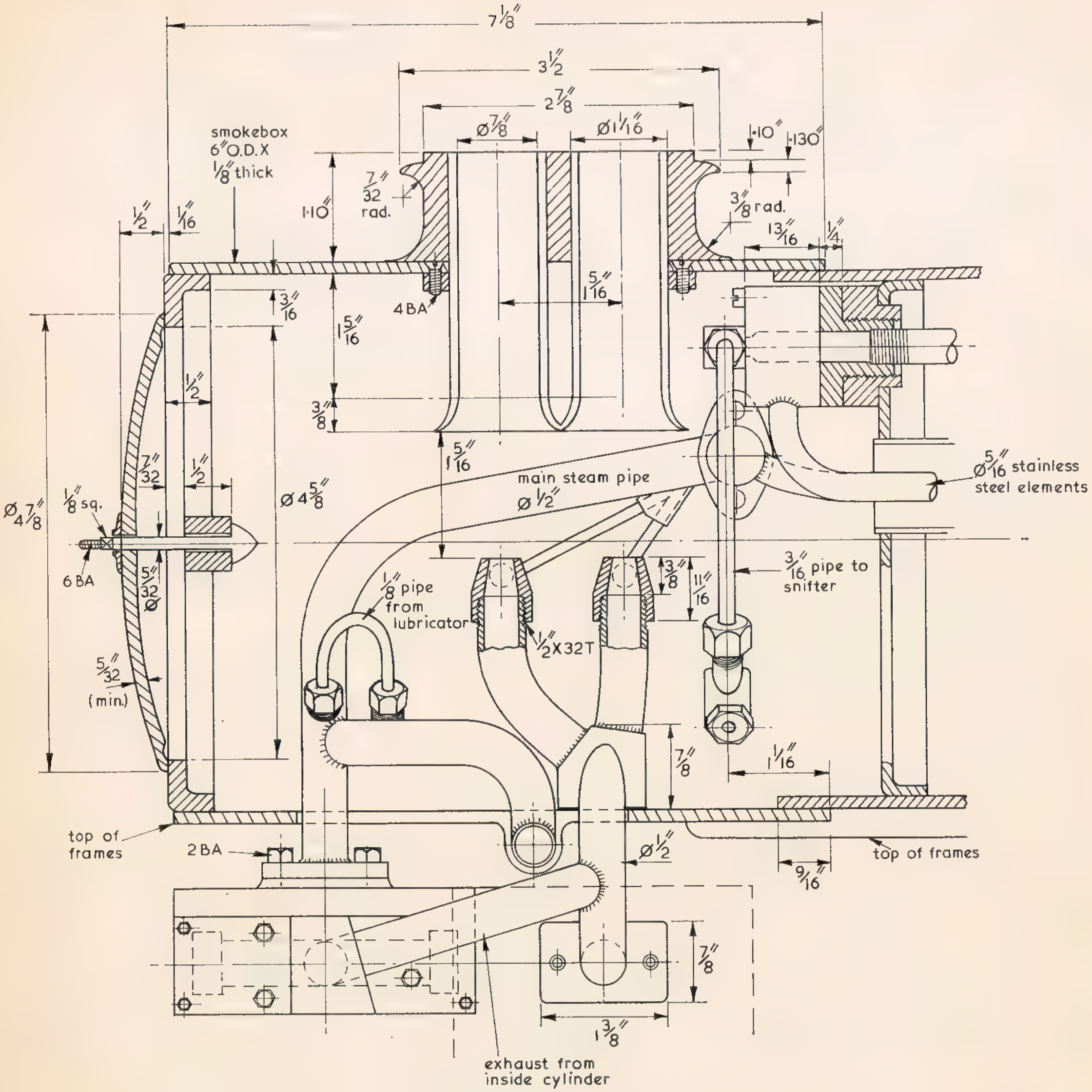
REACH ROD and REVERSING GEAR



Note X: This joint must be quite steam — tight —— use thin annealed copper washer



DETAILS OF SMOKEBOX DOOR



Note: diameter of blast pipe orifices 1/4". Blower orifices 0·040"Ø

mately its mid point. This is fitted with a $\frac{1}{8}$ in. dia. pin which works in a curved slot cut in the reach rod, which is made wider at this point. This fitting will prevent any tendency of the reach rod to whip.

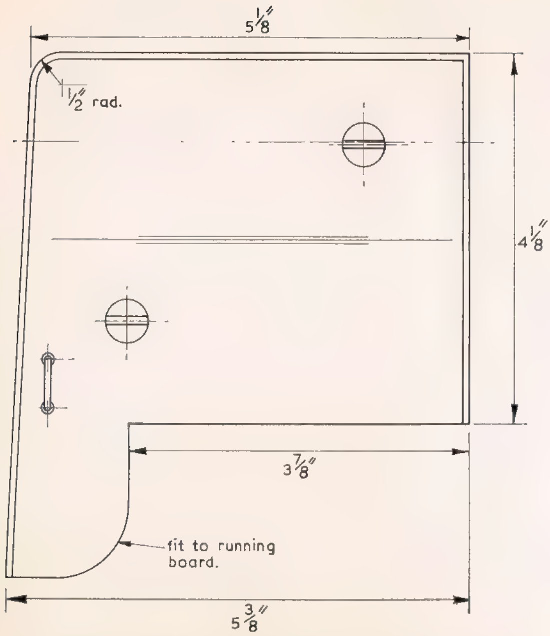
The cab fittings may be as described for *Royal Engineer*, one check valve being used, for water feed from the tender hand pump, as the usual two injectors will feed into the top feed fitting ahead of the dome.

The correct tender for "King's Own" is of course the standard Stanier 4000-gallon type, described in the 5 March 1976 issue.

The full-size drawing of "King's Own" is now numbered LO.944 sheet 1, and the boiler drawing is LO.944 sheet 2.

HAPPY CHRISTMAS!

Best wishes from the staff of "Model Engineer" to all readers, contributors and advertisers



SMOKE DEFLECTOR

CYLINDER BORING 200 YEARS AGO

by "Tubal Cain"

THERE CAN BE few model engineers who are not familiar with the standard of accuracy achieved by the Wilkinson Boring Machine when making cylinders for James Watt's engines; round within the thickness of a sixpence. This machine was put down in 1775, at Bersham, near Wrexham, and was a considerable improvement on the "Carron" boring machine installed at their ironworks by Smeaton in 1769. Prior to that date, Newcomen engine cylinders may have been bored on cannon-boring machines, but many were made by hand. The following is a contemporary account, found in the diary of the engineer Richard Reynolds, dated October 1760:

"Began this day to scour the bore of the great cylinder of a fire engine for drawing the water from the cole pit at Elphinstone, of a bore 28 inches across and in length nine feet. The same being cast of brass and after much discouragement and the spoiling of three before, which made us of much doubt if we could ever succeed in a task of such magnitude. But being by reason of the extremity to which the proprietors of the pit were at, having to employ more than 50 horses to discharge the water thereof, we were much urged to persevere, and we give great gratitude to Almighty God, who hath brought us through such fiery tribulations to an efficient termination of our arduous labours.

"Having hewed two baulks of deal to a suitable shape for the cylinder to lie therein solidly on the earth of the yard, a plumber was procured to cast a lump of lead of about three hundredweight, which being cast in the cylinder with a dike of plank and putty on either side, did make of it a curve to suit the circumference, by which the scouring was much expedited. I then fashioned two iron bars to go round the lead whereby ropes might be tied, by which the lead might be pulled to and fro by six sturdy and nimble men harnessed to each rope. And by smearing the cylinder with emery and train oil through which the lead was pulled, the circumference of the cylinder on which the lead lay was presently made of a superior smoothness; after which the cylinder was turned a little and that part made smooth, and so on, until with exquisite pains and much labour the whole circumference was scoured to such a degree of roundness as to make the longest way across less than the thickness of my little finger greater than the shortest way; which is a matter of great pleasure to me, as being the best that we so far had any knowledge of."

Reynolds was not the originator of this method (though he may well have thought it up independently) and an earlier, much briefer account of such a lead lap exists. In this case, however, the engineer cast "two strong hookes of iron" in the lead for attaching the ropes. Reynolds seems to have been a bit unfortunate in his foundry, for many large cylinders had been cast in brass by 1760; three "scrappers" seems rather excessive! The difficulties are the more surprising as far larger iron cylinders were in use at the time—one of 70 in. bore was at work in Cornwall in 1758. However, we mustn't be too critical—many of us have had scrappers with much smaller cylinders, 200 years later!

THREADING COPPER

SIR,—Recently two of the local society members had trouble threading copper stays and tapping the stay threads in their fireboxes. I have for many years been making models and have had good results using the following method:

I use genuine gum spirits of turpentine; it only costs a few pence for a small bottle, which lasts at least two large boilers. I dip a small paint brush in this and brush it on the copper, taps and dies. This gives a good thread, the turps burns off when heating for brazing and stops the copper oxidising. I thought this idea might interest your readers.

Paignton, Devon. Maurice A. Leeding

A SMALL POWER HACKSAW

by R. L. Tingey

THIS HACKSAW was first designed as an "accessory" to my Unimat equipment, and was originally made to be powered by the Unimat head driving through a rubber belt; but the belt drive stretched and slipped on the forward stroke, and relaxed on the return. This made the saw jump around the room, which was interesting but not entirely satisfactory. I redesigned the drive using a toothed belt system, which cut out all tendency to leap around, and provided excellent power drive. Later a sewing machine motor was fitted instead of the Unimat head, so that I now have the use of the lathe whilst sawing is in progress.

The advantage of this little saw is that, whilst it does not cut particularly fast, it saws very straight and gives an almost finished surface to the cut requiring little further attention. It cuts up to 2½ in. dia. round material, and about 2 in. square bar; it will cut copper tube for boilers with sufficient parallelism for working, but the weight must be removed when cutting down the tube sides. The saw uses a standard 12 in. high-speed hacksaw blade broken in two. Blade life is long as cutting is controllable by the amount of weight on the saw arm to suit the different materials, shapes and sizes.

The main consideration for the speed at which the saw will cut down is whether the swarf is cleared fully from the kerf, and, with the stroke of 2½ in., lengths of cut of up to 1½ in. are cleared well. Cutting lengths above this do not completely clear the kerf of particles and cutting down is slower. However, since the machine can be left working away unattended in safety this is no criterion. There is a cut-out incorporated which operates when material is sawn through.

Construction is in three main units:

1. Bed, made from square section duralumin, fitted with a steel vice, limiting rod, and integral cut-out.
2. Drive Unit, consisting of motor drive to the flywheel via a flexible rubber belt, driving shaft with two ball races and a toothed drive wheel; mostly of dural, with a brass flywheel.
3. Saw Unit. A column-mounted weighted arm along which a small saw reciprocates by means of a connecting rod driven by a large toothed wheel turning on a twin ball race.

The Saw

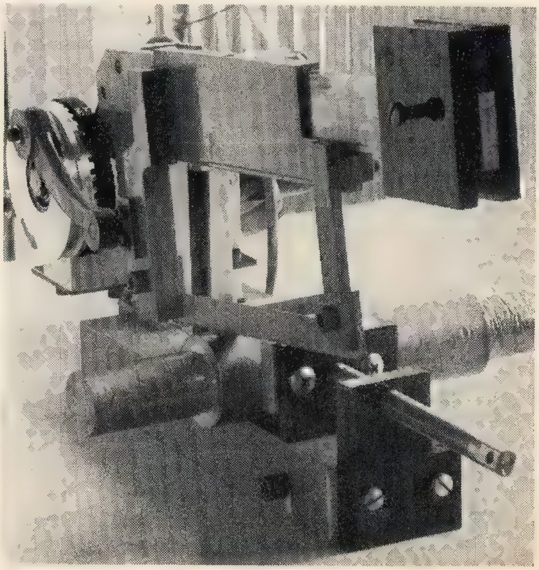
The most interesting unit to make is the saw. Start with a piece of angle iron (mine was a piece of old iron bedstead), place against a nice straight foot-length of 1 in. x ¼ in. b.m.s. Cut off all but ¼ in. of the top side of the angle and file to a clean fit of the arm.

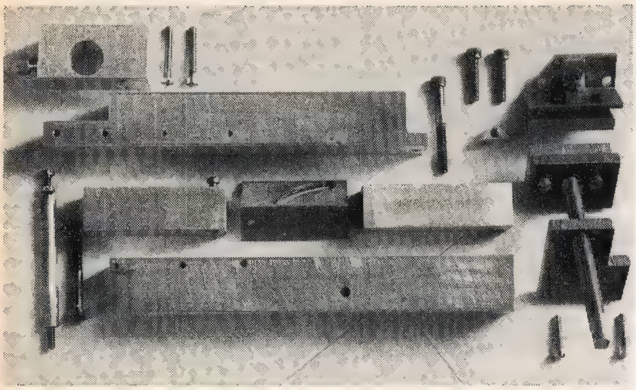
The secret of the easy running of the saw is the twin length of ⅛ in. round phosphor-bronze upon which the saw moves; cheap, easy to replace, but giving a smooth action. Put these in place with the ½ in. x ¼ in. b.m.s. tight up to them, place the side plate on top, overlapping the arm, and clamp together holding the ½ in. x ¼ in. piece, slide out the arm and phosphor-bronze. Drill through No. 24 in two places 1 in. either side of centre, ¼ in. from bottom. Drill out the angle and bar No. 13, countersink outside of angle, tap side plate 2 BA. Bolt together with countersunk screws, cut off surplus and file flush, remove screws, clean up with CTC, and secure both permanently with Loctite 270.

Make the bearing block for the top of the slide from a scrap of cast iron. File it clean and square on all sides, drill the two holes No. 43 and countersink. Mark out for corresponding holes on the thin edge of the angle, centre punch, clamp to the cross-slide of the Unimat, or to the bed of the drilling machine, and carefully drill, No. 50, ¼ in. deep. Tap 8 BA and secure cast iron block in place. Place phosphor bronze rods in their channel, hold, and slide in saw arm, oil well and the arm should slide as if on runners.

Make the oiling plate from a piece of dural, drill and countersink the oil hole and mill out the line

A general view of the hacksaw.





The components of the bed and vice.

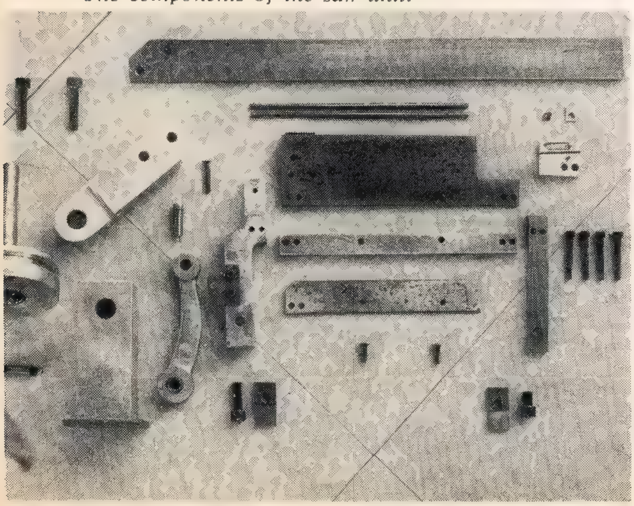
of the well. Secure a 3/32 in. pin protruding $\frac{1}{4}$ in. into the well side to keep the ends of the bearing rods.

The front leg is $3\frac{1}{4}$ in. of $\frac{1}{2}$ in. x $\frac{1}{4}$ in. b.m.s.; clamp this and the oiling plate either side of the slide front. Drill through No. 43 for the two holes of the hexagonal cap head securing bolts, tap the leg holes 6 BA and drill out other holes with a No. 33 drill. Clamp in place with 1 in. long 6 BA bolts.

Make the back leg from 1 in. x $\frac{1}{2}$ in. dural, sawing and filing to shape as shown. Clamp into position behind the angle and drill through with a No. 33 drill. Tap the leg 4 BA, countersink inner surface of the angle after drilling out hole No. 27. Secure with a 4 BA countersunk screw, checking that the head is well in the countersink. Drill two holes, No. 43, and complete as the front leg.

Remove the legs and drill a 6 mm. hole, central in each leg, $\frac{1}{2}$ in. from the bottom. Drill the oil hole in the top of the angle, No. 55 countersunk with a $\frac{1}{4}$ in. drill. Drill a No. 43 hole in the back end of

The components of the saw unit.



the $\frac{1}{2}$ in. x $\frac{1}{4}$ in. b.m.s. and tap 6 BA, make a small plate with a No. 33 hole and secure with a 6 BA cheesehead to keep the rods from sliding out backwards. Put everything together with Loctite 270, after cleaning well, saw off protruding threads and file clean.

The blade clamps are made from 3/32 in. mild steel; clamp flat in a vice and file half away, at an angle as shown. Drill through No. 10 almost at the cutaway and tap 0 BA. Use short 0 BA hex. cap head screws to secure blade.

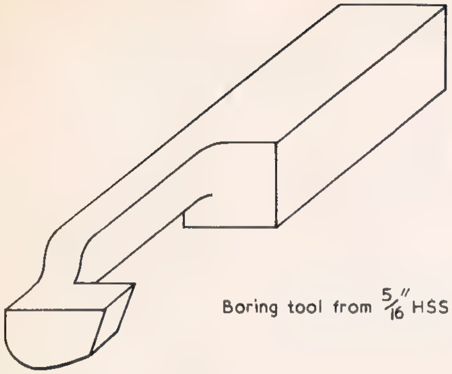
The connecting rod is duralumin, with a $\frac{3}{8}$ in. dia. big end bush, and a $\frac{1}{4}$ in. dia. swivel pin, both of phosphor-bronze. My rod was made from an old winding handle, already shaped; it can be made straight remembering that the centre distance is important. Loctite the bush in place with 601 and drill a No. 55 oil hole through, then a $\frac{1}{4}$ in. hole in the dural only. The small end swivel pin is secured with a 6 BA grub screw, and runs in the swivel plate, made from $\frac{1}{8}$ in. b.m.s., and fitted when positioned from the drive wheel.

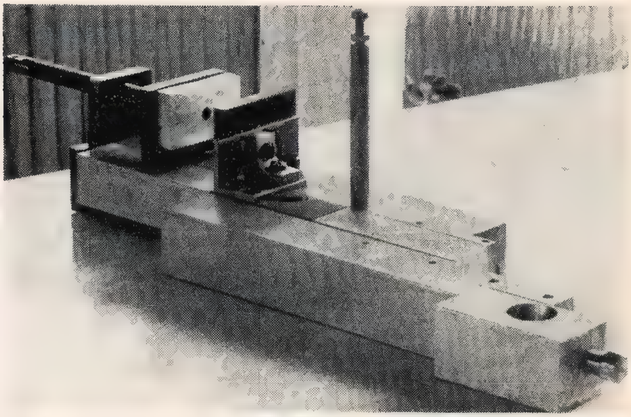
The Saw Drive

The saw is driven from a toothed wheel, turning about a spindle, on twin ball races. Use whatever bearings you can obtain easily and cheaply, under 1 in. O.D. Sealed for life bearings are preferable as swarf is excluded and oiling unnecessary. The size I used were 24 mm. O.D. x 8 mm. I.D. x 10 mm., and cost only 30p each. For the drive wheel use $2\frac{3}{4}$ in. dia. dural rod $1\frac{1}{8}$ in. wide. To turn this on the Unimat you will need a 20 mm. thick separation piece under the headstock and a similar block under the toolpost. The separation piece is "Adaptor", catalogue No. U1311, or it can be made from two lengths of 1 in. square dural bolted together with two 2 BA hex. cap head bolts, $1\frac{1}{2}$ in. long. Bore out 20 mm., right in the middle, then swing mill to the correct thickness. The toolpost block is approximately the size of the toolpost, but 20 mm. high and with a $\frac{1}{4}$ in. hole in the middle, secure with the longer T-bolt from a claw clamp, with a nut on top of the post.

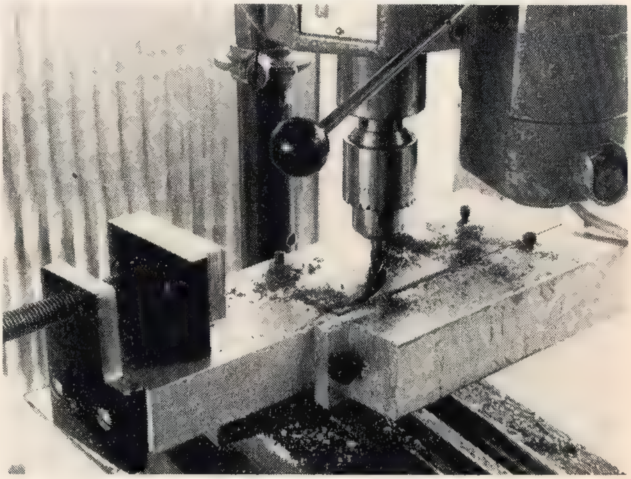
To bore the hole for the bearings use a tool as illustrated which starts well in a 9 mm. hole. Cut the hole both down the bore and across the bottom with the tool but avoid cornering the tool until the depth of the bore is correct, then take care to avoid biting in. When the bore is finished and the bearings a good push fit face the front surface, turn down the circumference available to a finish. Reverse in the chuck and take down the hub, then turn the part to be toothed down to 2.54 in. dia., for the 40 teeth.

The saw swivels on a crank arm made from 1 in. square dural as shown; bore a hole, centrally, $\frac{1}{2}$ in. from the bottom end, 12 mm. in diameter. Saw off the diagonal from the b.m.s. saw arm, drill the two





Above right: The assembled bed. The Unimat head fitting is altered as drawing.
Right: Milling the slot for the rear jaw of the vice.



6 mm. holes and match to the crank arm at 45 deg. Drill the crank No. 10 and tap 0 BA. Saw off the odd 45 deg. bits from the crank arm, and file to a finish.

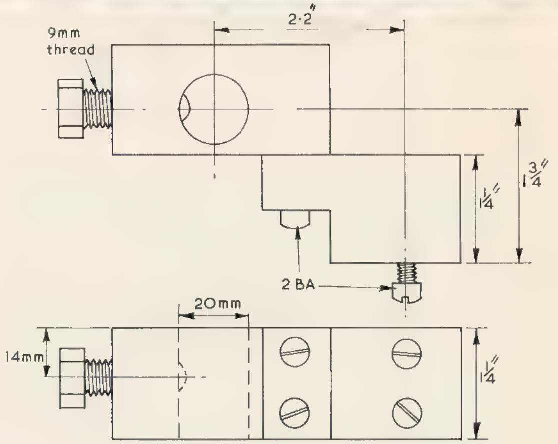
The pillar is $1\frac{3}{4}$ in. square dural; flycut the bottom dead square, then make the mounting plate from $\frac{1}{8}$ in. mild steel. Drill the plate with a No. 26 hole in each corner, and two in line, countersunk, No. 12 holes to secure it to the pillar with 2 BA screws. Drill the pillar No. 24, 1 in. deep, to match, and tap 2 BA. Bore a 12 mm. hole, centrally, $2\frac{3}{8}$ in. from the flycut end, drill a side for the grub screw to secure the spindle, and tap. Make the spindle from 12 mm. or $\frac{1}{2}$ in. b.m.s., turning one end down to a good fit in the ball races, and tapering to the large diameter so that the taper is in the hub. Drill the spindle end No. 24 and tap 2 BA, turn a screw from 7/16 in. AF brass to fit.

Put the lot together with two washers, 1/16 in. thick, between the elements. Mark the position of the big end boss, and the driveplate, to give a $2\frac{1}{2}$ in. throw. Remove ball races and spindle, then drill and tap the drive wheel for the boss, which is made from silver steel. Drill and tap the back leg for the driveplate. Secure the wheel in the 3-jaw chuck on the indexing attachment and cut 40 square teeth, as shown in my previous article.

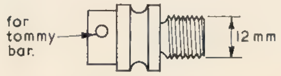
Clean up the wheel with CTC, run a cloth damped with CTC around the outside of one ball-race and secure race in the bore with Loctite 601. If you are using sealed bearings secure the second race in the same way; if the bearings are of an open type the second race must be left a push fit for the cleaning and lubrication of both.

Assemble the saw arm on the drive, position the drive plate with 6 BA bolts, connect up the rod, oil, and it is ready for fitting once the bed is completed.

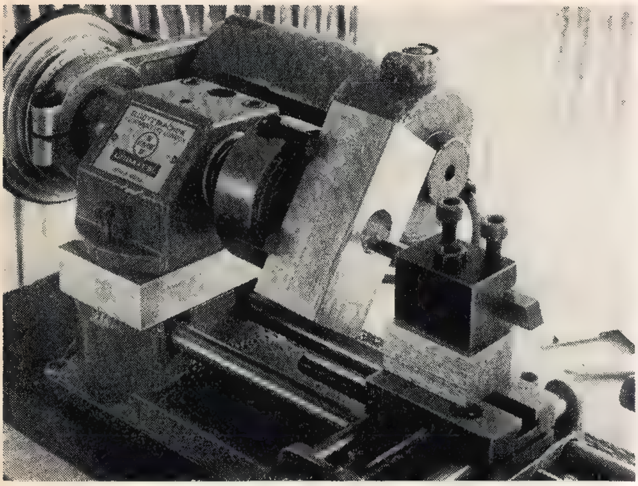
The bed is made from two outer sections of $1\frac{1}{4}$ in. square dural, with an inner section of 1 in. square dural, bolted together with 0 BA hex. cap



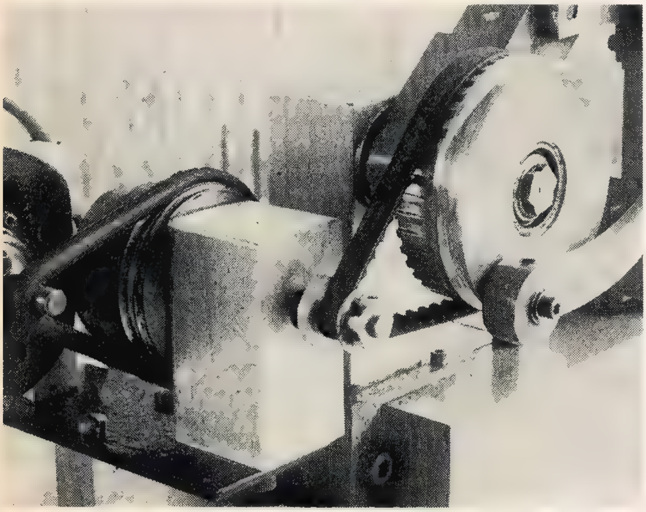
BED ADAPTOR FOR UNIMAT HEAD



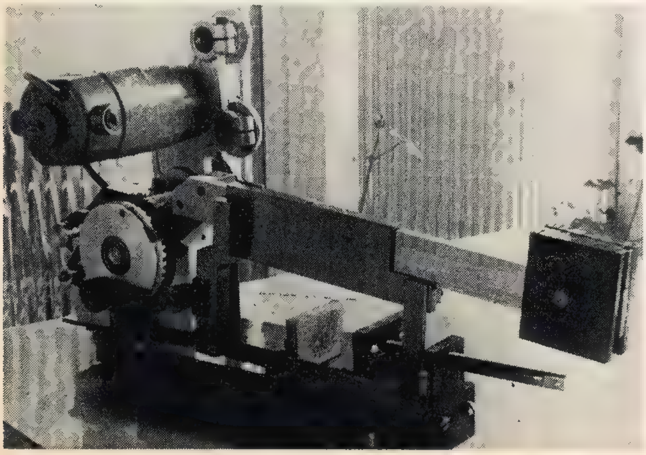
PULLEY TO FIT UNIMAT



Boring out the flywheel drive column. Note the blocks giving increased centre height.



The drive units with sewing machine motor fitted.
Below: The hacksaw driven with the Unimat head.



head bolts, and secured at the front end with the vice screw plate. The only complication is the integral vice, on which the back half, only, is made to swivel up to 45 deg. by means of a pivoting bolt and a lock screw travelling in a slot milled in an angle plate. The screw locks by means of a triangular nut beneath the angle plate, enabling travel to extend to near the walls. The front half compensates for the set angle with half round fittings dowelling into the front plate of the vice.

The bed is fitted with a microswitch and arm at the front end. When the saw has cut through, the blade descends on a hardened runner on the end of a spring-loaded arm, which runs through the bed block and is swivelled at its far end by a $\frac{1}{4}$ in. rod in a block. The arm, when pushed down, contacts a microswitch bolted to the bed and cuts off the supply to the motor. For safety all wiring and soldered terminals are thickly epoxied in place. The runner is made of silver steel and hardened right out, and it runs freely on the arm. The bed is cut away beneath the runner to avoid collection of swarf in the hole.

When the bed is complete, with a limiting rod fitted with an adjustable screw head, mark out for the position of the columns to give the saw blade 3/16 in. clearance from the side of the bed, exactly parallel, with the centre of drive 5 in. from the back face of the vice when it is at 90 deg. With these conditions satisfied the backleg of the saw will not strike the workpiece but provide maximum stroke length. The position of a limiting stop block on the crank can now be marked and a block fitted.

To drive the saw with the Unimat head make the extra bed block and the drive pulley which has an outside thread to fit the grinding wheel adaptor; the thread is made on the threading attachment. To fit the head use the 20 mm. thick adaptor beneath the head and the screw as shown.

The Flywheel Drive

This consists of a $\frac{1}{8}$ in. thick steel plate on which are mounted the motor support and flywheel column containing twin ball-races through which runs a shaft with a flywheel at one end and a small toothed drive wheel at the other. The flywheel is grooved to be driven with a rubber belt by a sewing machine motor, mounted on a 5/32 in. square support, or by the Unimat head. The motor support is secured to the plate with a single 2 BA countersunk screw and Loctite 601.

The flywheel column is bored for bearings the same as the drive wheel, using the raised headstock. The column is made from $1\frac{1}{4}$ in. square dural, $3\frac{1}{4}$ in. long, secured in the 4-jaw chuck. The bore is made in the middle of the piece and the surplus top sawn off afterwards; this is to prevent excessive vibration whilst boring. Bore out for the twin bearings from a 9 mm. hole; if open races are

to be used give an extra 1/16 in. depth. Cut off the surplus top, and flycut the bottom square. A ¼ in. spindle is fitted, so if the I.D. of the bearings is greater than this a dural sleeve must be made to fit. Clean sleeve and bearings and Loctite together with 601; with open races fit a small washer between races and drill oiling hole into top of column to correspond with the gap. Loctite the races into the bore. Make the brass flywheel, shaped to avoid hitting the motor, bore out ¼ in. and Loctite onto spindle; run a piece of cloth down between flywheel and column to keep Loctite from bearing. File a thin washer to fit small wheel teeth, as a flange, and make an annular flange secured with a 6 BA set screw, for the other side.

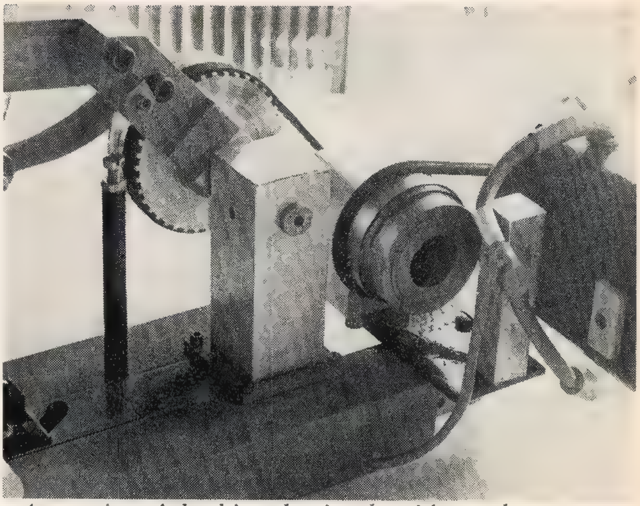
The column is secured to the steel plate with two 2 BA hex. cap head bolts; the holes in the plate are slightly slotted. Drill the holes in the plate, No. 12, for the bed screws, fit toothed belt drive after setting screws in the slots close to the saw side, pull tight and mark position of the holes on bed, drill No. 24 1 in. deep and tap 2 BA. Secure the plate to the bed with cheesehead screws. Loosen the two cap head screws and pull column over to tighten up the belt, tighten screws, side away from saw first.

Fit the motor; if the Unimat head is used line up the pulleys with the headstock lever, fit a flexible rubber belt with a round section, such as the Hoover cleaner small rubber belt. If another motor, such as the Jones sewing machine motor, is used, fit direct to the support, and run the belt, as described, directly from the motor spindle to the flywheel pulley.

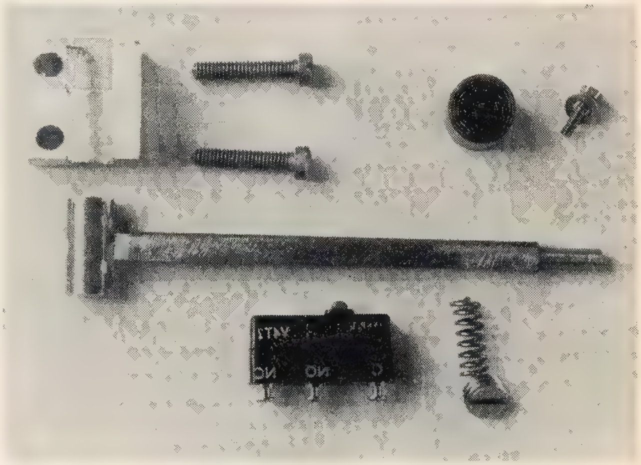
Make the weight from ¼ in. or 5/16 in. mild steel to weigh about one pound, for general work purposes. The cutaway of the slide allows extra weight to be fitted; for example, the small Unimat vice, inverted and clamped to the bar, makes a simple extra weight.

In use the speed of cutting indicates when the saw is cutting correctly. When cutting correctly the saw cuts more slowly; if the saw speeds up it means that the saw is not cutting efficiently, perhaps due to oil in the kerf, or sawdust causing the teeth to plane in a long cut. For block cutting use 18 teeth blades; for thin or angle sections use 24, and for copper tube use 32 teeth, with some variation in weight to suit material.

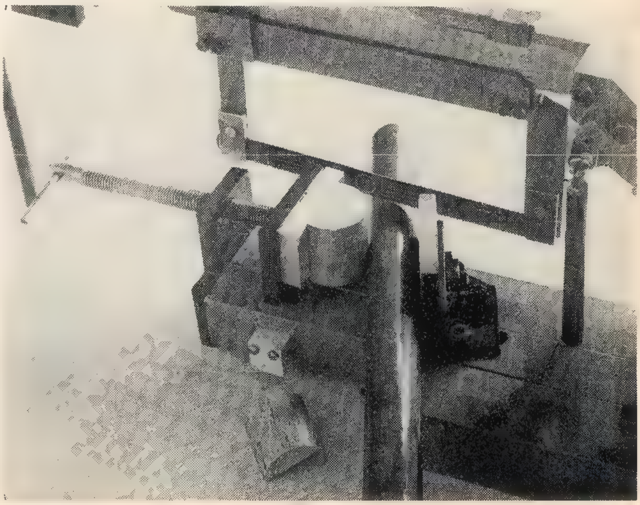
This is an easy saw to make on a small lathe; it is cheap to make and construction can be varied to suit the material available. But, above all, in use it saws with little waste, saving expensive materials.



A rear view of the drive, showing the wiring to the microswitch.



The components of the cut-out mechanism. Below: Using the vice at an angle.



ERRATUM

The drawing of the fly-cutter on page 1077 (5 November) refers to the article on the travelling steady for the Unimat, pages 961-964, and is used for boring the pass-through in the steady.

A Man and his Models: H. Clarkson of York

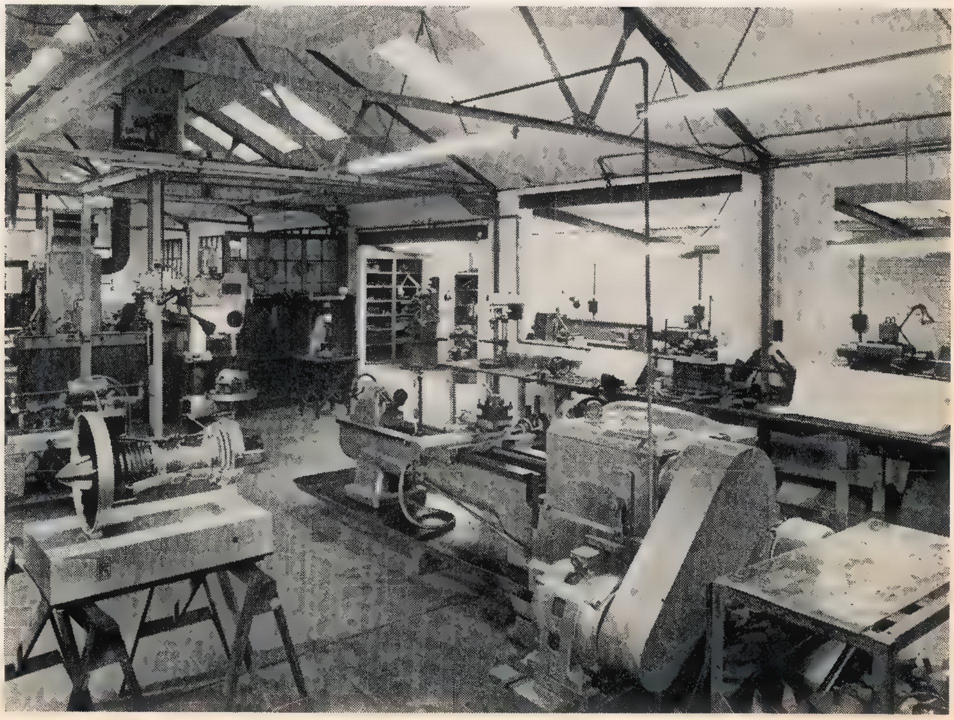
by D. J. Laidlaw-Dickson

LIKE MANY OTHERS, Harry Clarkson started his professional life as an amateur, making and entering models in early M.E. Exhibitions, contributing to the magazine and enjoying the friendship of the great J. N. Maskelyne. He served his time as an apprentice when steam was still king; and duly served and suffered injuries in World War II which forced him eventually to give up his work as a Crushing Mill fitter and take up the more sedentary occupation of model making. Which is how the firm of H. Clarkson & Son came into being. The back-garden workshop operation soon expanded into a thriving concern, but was, and still is, primarily a specialist company providing accurate scale models of absolutely anything and everything under the sun. In the course of developing this side of the business there has been a considerable offshoot of designs, plans and material for the model engineer, though this does not account for more than about a quarter of the company activity.

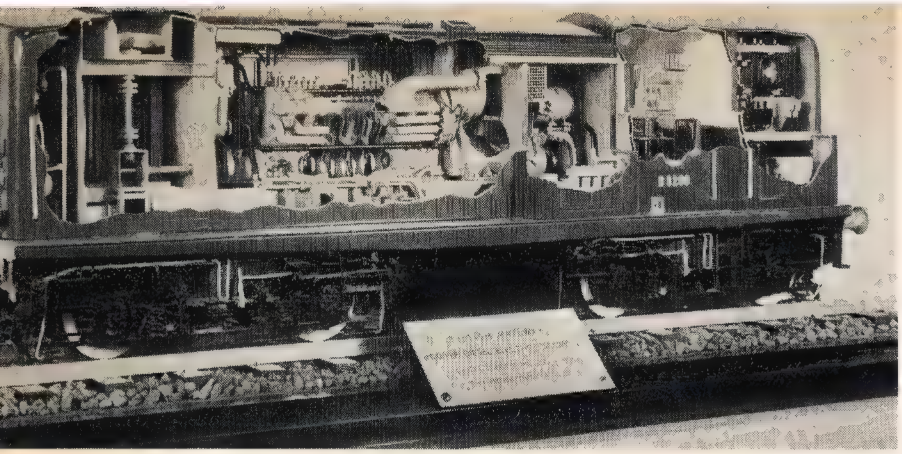
As a straight-thinking Yorkshireman, Harry Clarkson makes no special concessions to his modelling clientele. He regards them as *engineers* firstly and modellers a long way second and expects them to be able to read a plan expertly, interpolate any additional measurements, and in fact to enjoy that position once enjoyed by the fitter "who would know best!" What in fact he offers them is a wide ranging variety of choice from workshop accessories through stationary engines, including beam steeple and compound examples to 3 in. and 5 in. gauge versions of Gresley designs (on which he is something of an expert) but extending across what is virtually the whole range of main line locomotives — L.M.S., L.N.E.R., S.R., G.W.R., G.N.R., and lines less well-known. These are offered less because they are what the modeller wants but rather because they have been produced originally to meet clients' special orders and once drawn up can be offered economically.

There is a great deal of this kind of thinking in the works. Items in work I saw included a North Sea oil rig supply vessel in wood and metal, a 5 in. gauge version of the *Duchess of Buccleugh* 4-6-2 express passenger locomotive, designed as so many of their locomotives are by Harry Clarkson himself and destined for a client in Australia, and a 10¼ in. gauge Sandy River RR 2-6-2 for a passenger layout in North America, plus — improbably enough — an enormous brake drum from a juggernaut lorry that was being skimmed on their big 10½ in. lathe for a local authority. This last little titbit emphasises the engineer part of their activities. If it is made in metal they can do it! Quite a lot of council and engineering company work comes their way because they have the reputation of tackling anything from the humdrum to the near-impossible problem.

This may well be the reason that Harry Clarkson, though brought up on steam locomotives and mill machinery, and knowing every aspect of their construction and operation, confesses to an addiction to turbines. This dates back to his first departure into that field when Rolls-Royce gave him the opportunity to design working models of some of their gas turbines such as the RB211 Advanced Technology engine. This was produced as an electrically driven working model



This picture shows part of the works of H. Clarkson & Son of York.



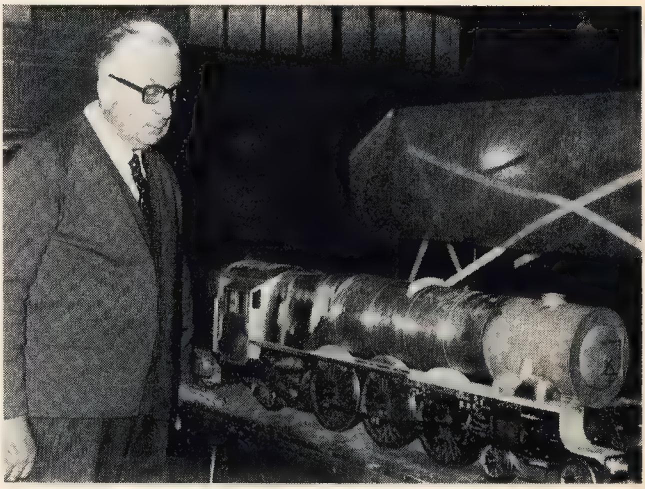
A ½ in. scale sectional model of British Railways' 800 h.p. diesel-electric locomotive built for the B.T.C. in 1958.

Below: Harry Clarkson with an unfinished model of a "Duchess".

for exhibition purposes with three shafts running at different speeds. Other exciting productions include the diesel Mayback MD/870 engines, built by Bristol Siddeley for Hymek locomotives—all scale working models, cut away to show movements of such items as double helical gears. Problems were rife with these designs—one small piece I was shown involved some two hundred separate soldering operations and yet was no larger than 4 in. x 1 in. dia.! Other regular clients have naturally included British Railways in spite of strong competition in this field. Contracts evaded him for some time since he was not prepared to compromise on quality, until quite by chance one of his models was seen by a top B.R. official, after which the way was clear and ultimately gave him the task of producing models of most of the then standard steam, D/E, D/H and 25 kV electrics culminating in the Deltic—shown in cut-away form.

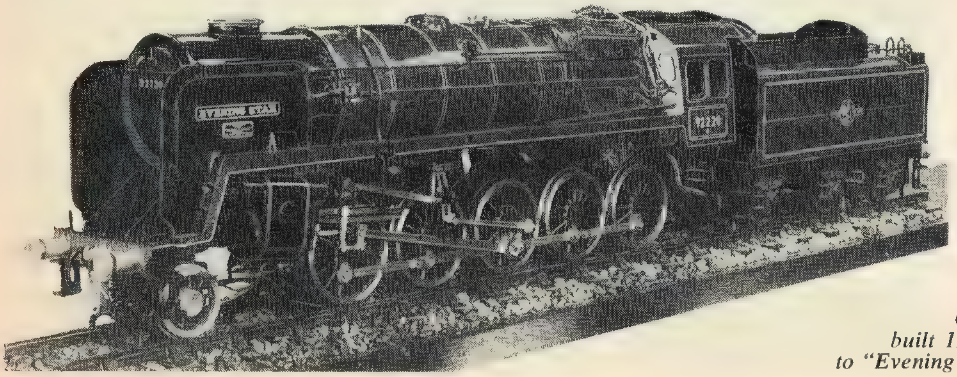
What sort of a works does an enterprise of this kind demand? On the face of it his 10,000 sq. ft. plus of workshop space may seem excessive for making little models. True, offices come out of this, and our own special favourite a delightful little mini-foundry occupying about 2,500 sq. ft.

Convenience of an in-plant foundry is immense; it enables shorter runs of castings to be made, keeping stores space down; allows for a more critical control of work—back to the pot for anything even slightly sub-standard; encourages pattern making for items that might be less economically fabricated. Certainly the Clarkson castings are beautifully sharp and clean-cut and another tribute to the pattern making which is Harry's special job. Monday he usually stays at home and works on the patterns. There had been a pouring the day I was there with the pleasant smell of moulding sand and cooling metal. It really must be a treat to be able to produce a pattern and have just one or two off without shopping round for a willing foundry with time to spare!

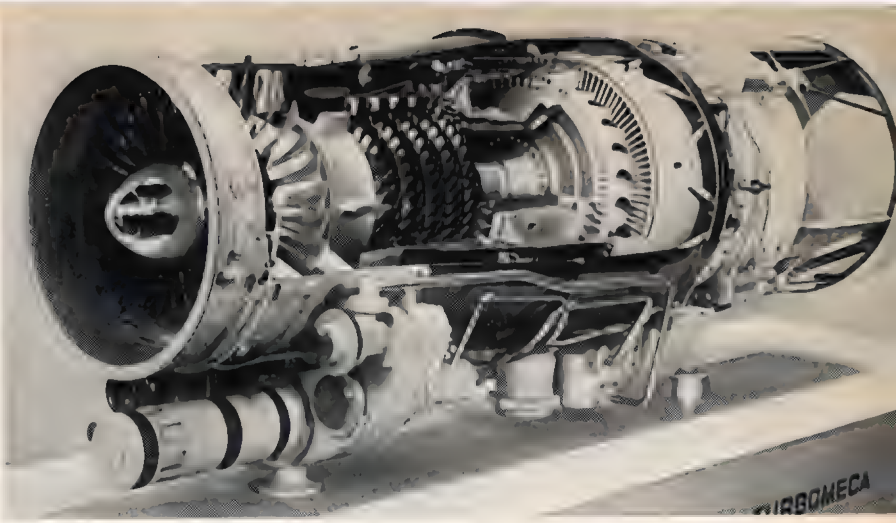


There are at least four melts a day of cast-iron, gun-metal, phos/bronze or aluminium.

Adequate floor space is however essential if good working conditions are to be enjoyed and the larger orders do take up a lot of space laid up for welding or other space-consuming operations. Nearly every one of the major pieces of equipment can tell a story of how and when it was acquired—like the 5 in. Raglan that was once the pride of the Raglan showroom in the days before Myfords acquired the company. That came to York in response to an urgent need, and Harry still pats it like a favourite steed—though now a little work scarred it still turns out the goods. Then there is a big Tom Senior milling machine which again came his way for friendship's sake when in short supply—it was actually on the lorry on the way south when the

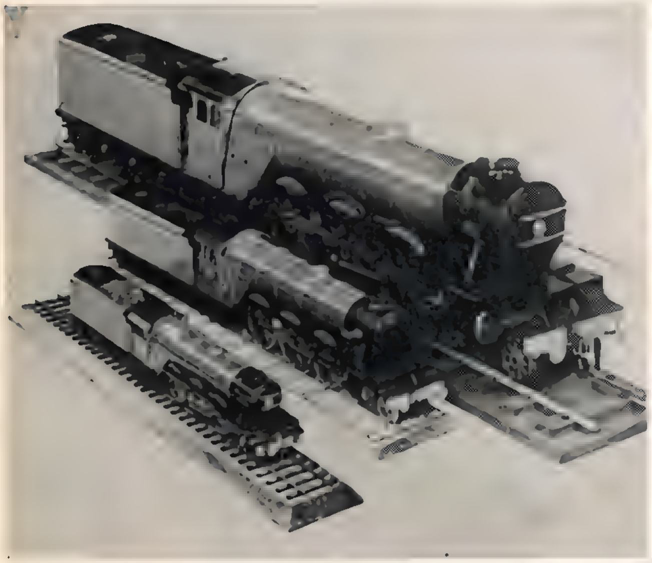


A ½ in. scale model of the British Railways standard Class 9 2-10-0, built 1955, converted to "Evening Star" in 1961.



A cut-away scale model of a Rolls-Royce RB 211 turbine.

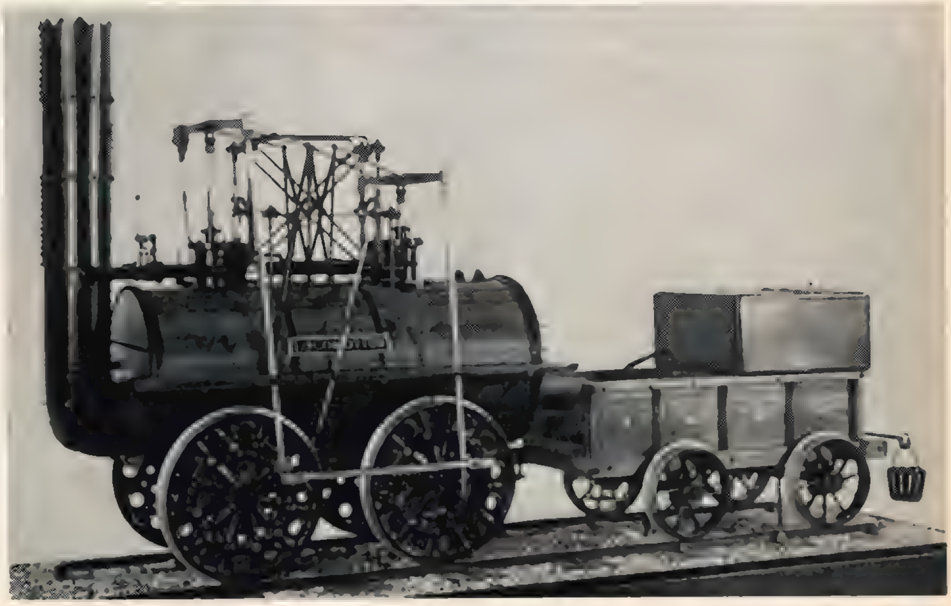
Below: Three models of L.N.E.R. "A.3" Pacifics built by Clarksons—7 mm., 10 mm. and ½ in. scale.



driver was stopped and returned to deliver it at Layerthorpe. Nor should the sturdy Colchester be forgotten or the team of Myfords inseparable from any modeller's workshop—amateur or professional! Harry doesn't really like the Raglan, preferring the Colchester or Harrison. *Continued on page 1272*

Middle right: A ¾ in. scale model of East African Railways Class 31E.

Right: A scale model of the "Locomotion", the first locomotive to work on the Stockton & Darlington Railway.



MORE TRICKS WITH THE "QUORN"

Part II

by Professor D. H. Chaddock CBE

From page 1190

THE ENGRAVING SPINDLE itself is mounted in a spherical ball joint so that it can be set at any angle to the work, but still rise and fall vertically with the main machine spindle, the plastic belt allowing a good deal of angularity without unshipping. This feature has proved extremely valuable in certain die-sinking-like operations where for example a rectangular recess has to be machined in the corner to a very small radius but the sides of the recess have to remain vertical.

The otherwise finished rocker box covers are held by their own 12 BA set screws to a slave plate clamped to the table of the milling machine which was convenient since it meant that each, and there are four to do, could be removed between operations and put back again without losing alignment and all were identical. A setting piece, visible under the cutter, was machined to the internal contour of the rocker box covers plus 0.040 in. thickness to be left at the root of the fins and served to set the cutter to depth before each pass. Finally an air blast pipe held in place by those most useful laboratory retort clamps and fed from a small rotary blower keeps the cut free of chips. This is most important, particularly with small cutters which go on cutting their own chips to dust as well as cutting fresh metal. This not only imposes extra work on the cutter, thereby blunting it earlier than need be, but it spoils the finish of the work and may lead to chip jamming and cutter breakage. So another "impossible" task was done by spending time and trouble to get the tools right, after which it presented no difficulty whatsoever.

Finally readers may have seen the QUORN in its new guise shown in Figs. 11 and 12. In this form it is really intended for commercial exploitation with the mandatory belt and wheel guards required by Factory Regulations, but as considerable interest has been expressed in it our suppliers have taken over the patterns and drawings and can supply either Mk. I, the old machine, or the Mk. II, which this is.

The principal differences are in the wheelhead. New patterns and castings have been made so that the rocking portion embraces the fixed portion, but the adjusting screws and the spindle are the same. This gives a cleaner exterior with fewer crannies to collect the dirt and is rather easier to machine. The wheel guard clips on to the end of the grinding spindle quill and can be used with either Mk. I or Mk. II machines. The driving motor is end mounted on an adjustable motor mounting plate which can be moved backwards and forwards to adjust the belt tension, a necessary feature if a fixed

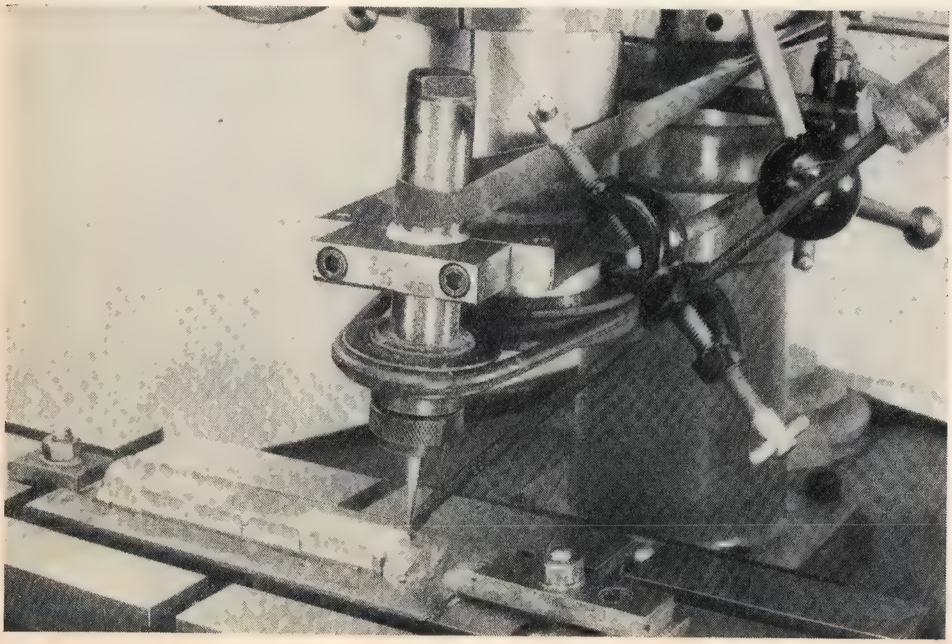
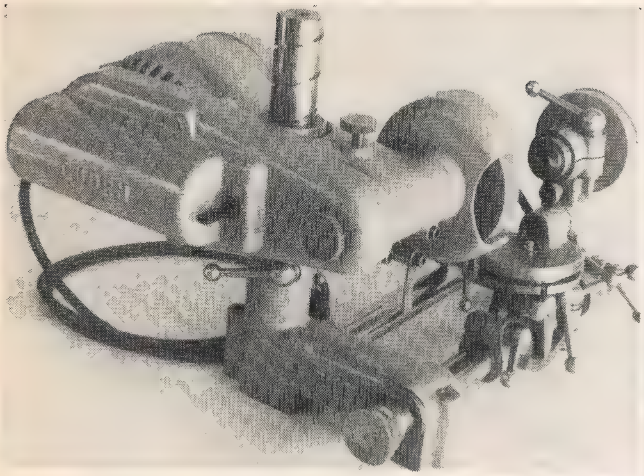


Fig. 10: Milling variable depth fine pitch fins in a component.



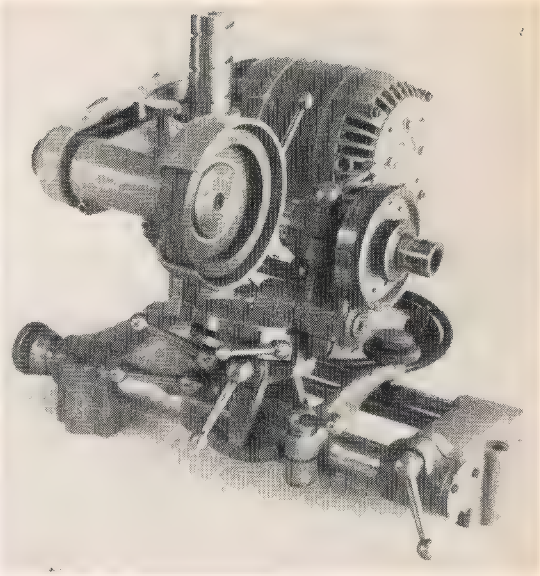


Fig. 11: The "Quorn" Mark II, with belt and wheel guards.
Right, Fig. 12: The Mark II wheelhead with end-mounted motor.

length belt is to be used. The existing motors can be used by sawing off the feet, bringing out the leads at the other end, shortening the spindle by 1 in. and tapping the already cored holes in the end cover. New motors to this specification can be obtained but with considerable delay in delivery. The belt and pulley guard completely encloses these items and houses the motor capacitor and a two way stop, start and reverse switch without any exposed wiring.

A feature not shown in the photographs but now fitted to the machine and shown in the new drawings is an index ring keyed to the vertical column which gives the angular position of the wheelhead in relation to the rest of the machine. Few changes have been made to the rest of the machine except that felt wipers have been added to the moving parts on the front bar and an additional boss added to the workhead so that the tooth rest can, if necessary, be mounted on it instead of the vertical column. Other minor modifications include the spiralling on the vertical column which can be conveniently reduced to $\frac{1}{2}$ in. pitch or thereabouts and, as already mentioned, redimensioning of the wheel arbors, spindle nose and draw spindle to inch sizes when collets are not to be used.

Whether the Mk. II is better than the Mk. I is really a non-question since they are designed for a different purpose. The Mk. II is intended to be sold as a complete machine, wired up and ready to go, although it is not yet available in that form. But it is less versatile than the Mk. I which will accept any size of suitable motor and to which various sizes of driving pulley can be attached. This is deliberately made impossible in the Mk. II where the belt guard limits the maximum size of pulley that can be used to give a safe speed to the largest wheel that can be accommodated in the wheel guard and the wiring is such that the machine cannot be run with the belt and pulley guard removed. It is however much neater and the other modifications which are common to both machines are worth incorporating and although they are not detailed here they can all be obtained from the new drawings.

An old Clayton portable engine.
See letter, page 1295.

An Attachment for backing-off Milling Cutters

by Dr. A. R. Bracey

THE NECESSITY for the construction of this attachment arose from the requirement to make a 45 deg. $\frac{1}{2}$ in. dia. cutter to make a dovetail. The teeth—four in number—were cut by hand but the problem was to back off the teeth to give clearance. This the attachment will do and will cut the teeth as well. In principle the cross-slide is used to cut the teeth and the cutter blank rotated on an eccentric centre to back the teeth off.

The attachment consists of five parts as seen in the general arrangement drawing. The block Part A holds the bush Part B which holds the shaft carrying the cutter blank, this shaft being on an eccentric centre. The bush is rotated by Part C. Part D is a collar carrying two sets of indexing divisions, 12 and 16.

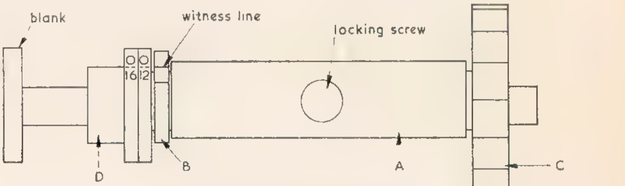
Part A is made from dural bar 1 in. x $1\frac{1}{4}$ in. x 4 in. As indicated in the drawing a $\frac{1}{4}$ in. x $\frac{3}{8}$ in. tongue is milled to be a close fit in the slots of the vertical-slide. In the remaining square section a $\frac{3}{4}$ in. dia. hole is bored centrally. Part B is from dural bar 1 in. dia. and 5 in. long reduced to $\frac{3}{4}$ in. for all but 3/16 in. of the length to fit the bore in Part A. This bush is bored $\frac{1}{2}$ in. dia. but 1/16 in. eccentric to the outside diameter. A small piece of dural 3/16 in. x $\frac{1}{4}$ in. x $\frac{1}{2}$ in. is Araldited to the collar left on one end. The outside surface is later turned to match the diameter of the index collar. A handwheel Part C also from dural $2\frac{1}{4}$ in. dia. and $\frac{1}{2}$ in. wide is locked to the bush at the left hand end using a 2 BA Allen screw. The circumference has finger holds of $\frac{3}{8}$ in. radius turned on a $2\frac{1}{2}$ in. dia. pitch circle using the Myford indexing attachment. The collar Part D is made from $1\frac{1}{2}$ in. dural bar with a $\frac{1}{2}$ in. length reduced to 1 in. dia. and tapped 2 BA for the locking screw. A $\frac{1}{2}$ in. hole is bored. The large diameter has two index rings, one of 12 divisions and one of 16 divisions.

The cutter blank is carried on a $\frac{1}{2}$ in. shaft with the end reduced to $\frac{3}{8}$ in. A 1/16 in. key is fitted and engages in a slot in the blank, this being prevented from coming off by a 4 BA c/s screw. The blank is undercut to accommodate the necessary washer and screwhead.

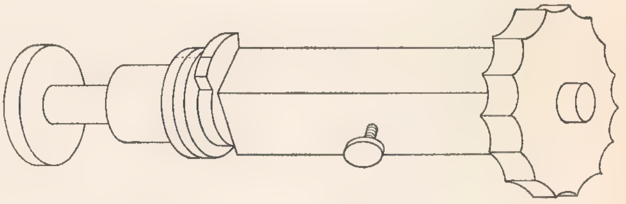
In use, the holding block (Part A) is clamped to the vertical-slide and the face of this adjusted to 45 deg. or parallel to the lathe bed. The bush (Part B) is a permanent part of the attachment. The index collar is slid on the cutter blank bearing shaft which is then inserted in the bush and locked with the 2 BA Allen screw. The shaft and collar are rotated to bring the first division against the witness mark. The bush is also locked so that shaft bore is at the lowest point in the bush. An end mill is set in the chuck and the vertical-slide raised or lowered to enable the end mill to cut on a diameter line. The cross-slide is then moved to cut the tooth. The size of the end-mill is conditioned by the size of cutter blank and the number of teeth. The shaft is indexed round and the teeth cut in rotation.

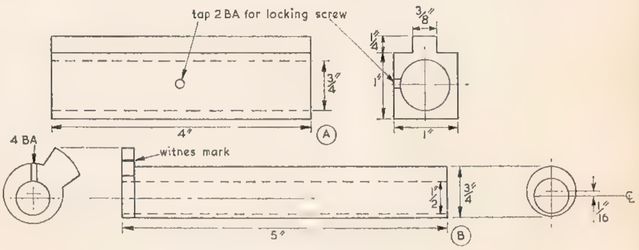
After all the teeth are cut, the cross-slide is locked so that the end mill can just skim the teeth. The bush is now unlocked and rotated anti-clockwise to back off each tooth, again using the index collar.

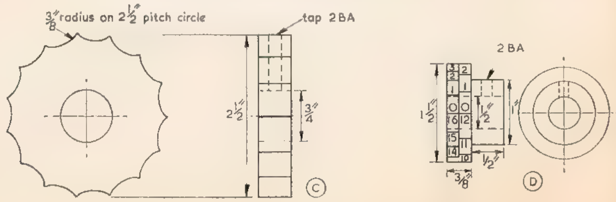
Since such cutters as these may only be used for one job, I have used mild steel and case-hardened it after forming the teeth. Silver steel could be used and hardened and tempered to enable re-sharpening if more than one job was to be done. The two cutters made with this attachment served their purpose very well.



GENERAL ARRANGEMENT







JEYNES' CORNER

E. H. Jeynes on small lathes

I NOTICED with interest the Editor's remarks in "Smoke Rings", 1 October, having regard to small lathes, mentioning the Perris and Unimat machines. I have seen some very nice work on the latter machine, quite as large as the wheel size being experimented with. Effecting speed reduction by belt and pulleys takes up room, which often cannot be spared, so I would vote for a worm gear reduction for the first stage, to allow of larger pulleys to be used. While speaking of worm gearing as applied to the power hacksaw machine illustrated I hope the motor rotation is arranged to allow the air to be expelled through the openings in the motor endshield, or that they are blocked up, otherwise I can see some trouble in store for Mr. Balfour if cast iron dust is drawn into the space between rotor and stator.

The recent mentioning of the prices of small lathes sent my thoughts back to the days when £1 bought twenty shillingsworth, that is if you had the pound to spend. Many of the early model engineers had only quite primitive plain lathes to work with, many of which did not even have a slide rest, but much beautiful and accurate work was produced by hand tools, on this type of machine. Holmes of Bradford produced and advertised in *Model Engineer* a 3 in. centre plain bench lathe with a Tee rest for 17s. 6d.; and Patricks of Leeds advertised a 2 in. centre lathe for £1 15s., in 1921.

In the early years of the century, several makers of larger lathes turned their attention to the design and production of smaller lathes. To mention one, Messrs. Drummond Bros. turned out a 3½ in. centre treadle lathe for £13 10s., and later produced their famous 4 in. centre round bed lathe at £5. Many of these lathes still survive and sometimes change owners at fantastic prices. Admittedly these lathes were far from perfect, the 3½ in. lathe having the leadscrew in the centre of the bed among the chippings, and the wear of screw and nut was rapid, the 4 in. lathe had no back gear, and the addition of a reduction gear such as the "Walram" instead of increasing the depth of cut which could be taken, merely moved the saddle around the bed; at least that was my experience, and I owned an example of each type. The Henry Milnes and the Britannia small lathes were good sturdy machines being more or less the larger lathes in design, but reduced in size. Gap pieces were accurately fitted, and horns to the saddle which greatly increased the area of bearing surface on the bed. The tumbler reverse with "centre-off" position was also of great use, as was the split nut for leadscrew; but as Mr. Thomas remarked recently, there were quite a number of small lathes that were not so good.

Among the smaller lathes, I wonder how many can remember the 2 in. centre lathe produced by Drummond Bros., the "Little Goliath" which allowed 5 in. between centres, swung 4 in. over the bed, 2 in. tailstock travel, fully compound slide rest with steel screws and handwheels, complete with centres and driving chuck, one hollow and one solid chuck and one hardened turning tool. Price £3 15s. Carriage Paid. I imagine the Postal or Rail Authorities would charge as much as this today to just deliver it. Incidentally, this lathe could swing 5 in. in the gap.

At various times, some departure from the well beaten path of lathe bed design has been made. Apart from their round bed lathe, Messrs. Drummond produced a double deck bed, the top one finishing short of the headstock thus forming a gap: this portion of the bed being solely for the tailstock and steady (when fitted), the saddle traversing the lower portion of bed. This lathe was produced for Military and Naval workshops, and if I remember correctly, the centre height of those fitted in the mobile workshops was 5 in., and those for the Admiralty were 7 in. centres. Some of these lathes have survived and I expect they are greatly prized by their fortunate owners, although they must be well over 50 years old, having been produced for use during World War I. Some makers produced lathes having a saddle bearing surface on the front, as well as the normal surface, and some lathes had inverted Vee sliding surfaces; some small lathes have two ground round bars for their bed, while many older precision lathes had accurate triangular beds. I believe Miss Cherry Hinds produces her beautiful models on such a lathe.

Well over 50 years ago Henry Greenly designed a lathe especially for model makers: this was manufactured by the Jackson Rigby Engineering Co. and was exhibited by them at one of the Model Engineer Exhibitions, this lathe being designated the J.R. lathe. Another model maker's lathe was the Bowker round bed lathe, produced in Sheffield. While a lathe which was in fact a universal machine tool, was designed by Mr. Urwick, who is now resident in Malta. This design has been taken up and a full-size universal machine tool produced, being designated the "Labormill". In this design the centre height is adjustable by raising or lowering the bed, while the tailstock is carried by a separate member protruding from the headstock in the manner of horizontal milling machine practice. Mr. Urwick gave a description of his invention in *Model Engineer* 4 January 1974 in a well illustrated article covering five pages. Mr. Urwick is the patentee of a triangular "Gib" key, which would have done much to prevent the rotation of the saddle of the 4 in. round bed Drummond lathe I have mentioned.

Now and again, it has been possible to purchase from a scrapyard, a lathe which, while perfectly good in some respects, has been scrapped because of wear or breakage of some part. A friend of mine many years ago managed to effect a splendid buy in the form of an American straight bed lathe, which had suffered the removal of the leadscrew, rack, and the self-act shaft; everything else was in reasonably good order. As he intended to use the lathe for wood turning only, he snapped it up at a bargain price, but later having undertaken some work which required the saddle moving along the bed by hand, he asked me if I could help him rig something up for this purpose. As it was only required to move the saddle from one point on the bed to another, I evolved the idea of a flexible rack to replace the missing bed rack; this was done by extending a discarded motor-cycle chain, between the bearings which had previously carried the leadscrew, with means to keep it square and fairly taut, and removing the gear-down wheels from the apron, and fitting a sprocket to suit chain on the traverse handwheel shaft, while a hardwood guide was fitted to keep the chain and sprocket meshed. This Heath Robinson kind of job exactly filled the requirement, that is to move the saddle along the bed to where it was required.

Reverting to the model engineers of say 50 years ago, to have stepped into one of their workshops would be to find the motive power for the lathe was "Shank's Pony" or a small gas or oil engine, the lighting being by incandescent inverted mantle; today, the small single phase motor provides the motive power almost everywhere, and the lighting fluorescent.

MODEL STEAM BREAKDOWN CRANE

by E. Cheeseman

SINCE EARLY DAYS I have always wanted to be an exhibitor at the Model Engineer Exhibition, and after the successful exhibition at the 150th anniversary celebrations of the opening of the Stockton and Darlington Railway of my Breakdown Train (the steam crane performing a sequence of operations, Lifting, Luffing, Slewing, and Travelling with a load, then reversing the procedure, for 20 days), the thought struck me that if transport could be arranged here was my chance. Through the good offices of Vic Smeed and his strong-armed gang, and those of John Hall-Cragg who arranged the vital transport, the crane and its match truck appeared at the Seymour Hall, as part of the 1975 Exhibition; and I was able to rub shoulders for a brief interval with the élite of the model engineering world.

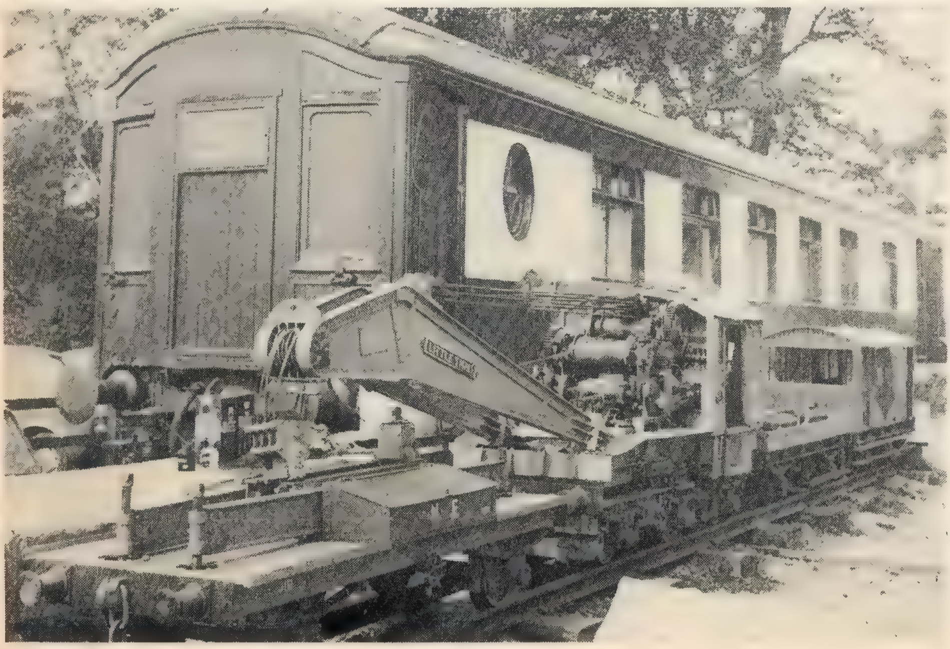
I felt rather hurt that none of those reporting the Stockton and Darlington celebrations even mentioned what was probably the only hard-working steam model present, but I was gratified to see the photograph in *Model Engineer*, 20 February, although again it was not mentioned in the text. However, I am perfectly satisfied with the reception *Little Titan* is given, whenever she ventures before the general public's gaze. The most recent occasion was the "15 inch gauge Get Together" which took place on the Ravenglass and Eskdale Railway from 18 to 25 September. From the questions I was asked, and the photographs I saw being taken, it was evident that a great number of people were somewhat interested in her performance, so I think a few words on the design and construction may be of interest.

The Breakdown Cranes used by the various railway companies around the turn of the century were mostly constructed as "one off" jobs, and lack of information, and drawings, forced me into the "corridors" of engineering design, willy nilly; and many hours were spent with slide rule and drawing board before I arrived at finality of design, which required the following specifications: there were to be no old fashioned "dog clutches" to connect the power unit with travelling, hoisting, luffing and slewing operations; no old fashioned vertical centre-flue unlagged boiler; and no old fashioned single eccentric rocking link reversing gear. Instead, there was to be a vertical multi-tubular boiler, efficiently lagged, a two-cylinder engine with full link motion reversing gear, transmitting its power to the various motions through differential action, bearing in mind the finished crane must be contained within scale dimensions, and having an air of early 20th century about it.

At first I fixed upon a lifting capacity of 3 tons, therefore the chassis was constructed to be capable of sustaining the weight of the crane and its lifted load, so for a good margin this was built to sustain 6 tons. The crane was to be capable of travelling at 3 miles an hour, and to endure long operational periods without dropping of steam pressure. There were to be as few energy consuming plain bearings as possible, therefore ball and roller bearings were freely adopted.

While still in the design stage, I found that the reactionary load on the slewing retaining ring when lifting 3 tons required the diameter of this to be much greater than the scale width of the crane, and further, the only lathe I had access to could only swing 25 in. dia.; so determining the diameter at this, and the idea of a 3-ton crane died on the spot, the lifting capacity was thus reduced to $1\frac{1}{2}$ tons, and a pair of stabilizing beams with screw jacks at each end were made as part of the equipment of the match truck.

The slewing ring takes only the vertical loading, all the horizontal load component is taken by the "king



The 15 in. gauge model breakdown crane photographed alongside a standard gauge Pullman car.

The crane slewing to place a 2½ cwt. steel bogie on the rails.

post" assembly, which supports the entire travelling gear modules, the drive of which passes right down its centre. These modules contain no less than 11 ball races, and four sets of bevel gears, and of course, the whole crane revolves on the king post.

The advantage of differential drive over the conventional "dog clutch" drive is its ability to make or break the drive without stopping the engine; also such drive engagements are smooth and quite devoid of shock. In the cab a bank of four control levers is fitted, the operating shafts all being concentric. These levers work in quadrants, there being one lever for each basic manoeuvre; the central position in the quadrant for each lever is "No drive at all", or neutral position. Forward position gives in each case "Hold", i.e. the brakebands are contracted on say the hoisting rope drum, and holding a suspended load, while the crankshaft is driving the input shaft to the input side of every module; with the lever position to the rear, the "Hold" brake is off, and the drive brake is applied.

Two thoughts will immediately occur to the reader: on moving any lever from "Hold" to "Drive", it must pass through the "No brakes on" central position; for slewing and travelling this has no ill effect on the working of the crane. However when lifting and luffing, the force of gravity will act upon the jib and the load, and to prevent them crashing to the ground as the lever passes through the central position, each rope drum has a second braking system and this is interlocked with its respective lever.

The second point is that as the drives are not positively positioned dog drives, the levers cannot take up positive positions for "Hold" and "Drive" for band brakes demand a form of ratchet controlling lever, where the "Brakes Applied" position can vary according to the state of wear of individual brake bands, therefore it will be noted that the ratchet teeth point outwards from the centre of each quadrant assembly; i.e., each lever has a pawl and ratchet that works as a holding ratchet both ways from the centre of the quadrant. So, basically, the four control levers each control two sets of brake bands. on the basis that when one is "On" the other is "Off" and vice-versa.

The final design of the boiler was a compromise, related to the limited supply of 1 in. by 3/32 in. thick flue tubes and about 2 ft. of 18 in. dia. high grade steel pipe, and there was one constant I could not waive, the scale loading gauge height. After much thought, I decided to make the firebox as wide as possible, and this demanded that a "dry" firebox be adopted; this was given no half measures with insulation to keep the heat in. I noticed that after 6 hours of steaming, the hand can be held against the box side.

To be continued

A view of the crane with one of the stabilising beams in position.

CLUB NEWS

Northern Association
The Northern Association of Model Engineers now has 41 member societies, mainly in the North of England, but including the Dublin and Sussex societies. The Association plans to hold another exhibition in 1978, which will be in the Stoke-on-Trent area.
Mr. Stuart J. Daw has recently taken over the duties of Secretary, and his address is 177 Queen's Road, Penkhull, Stoke-on-Trent ST4 7LF. Tel. 0782-48942.

A.G.M. at Warrington
The Annual General Meeting of the Warrington & Dist. Model Engineering Society was held in October. Officers elected were as follows: President, T. Steel; Chairman, J. Mercer; Secretary, J. S. Doyle, 37 Grove Road, Hoylake, Merseyside L47 2DS. Committee members—Messrs. G. Fleet, A. Hall, H. Wood, H. Pugh, J. Wilson, E. Goldsborough, G. Archer. Auditors — K. Bolton and I. Glover. The retiring officers, R Walker and J Shenton, were thanked for their services.
The chief aim of the Society in the coming year is to finish the extension to the track at Daresbury, near Warrington.

High Wycombe Society
The new Secretary of the High Wycombe Model Engineering Club is Mr. R. G. Wyborn, Moor Cottage, Plomer Green Lane, Downley, Bucks. Tel. High Wycombe 21712.

New City Model Society
The "bring and buy" sale earlier in the year was very successful and another was held on 30 November. The Smith Memorial Cup will be presented at the A.G.M. in January for the best model of the year, and it is hoped to have three other trophies, to be awarded for the best engineering, boat and aircraft models respectively.
The Society now has nearly 100 members.
Secretary: Mr. C. Orchard, 105 Highfields, Towcester, Northants. NN12 7EA.

CLUB DIARY

Dates should be sent at least five weeks before the event to ensure publication. Please state venue and time. While every care is taken, we cannot accept responsibility for errors.

DECEMBER

17 Worthing & District S.M.E. Annual Dinner. Thomas A'Beckett Hotel.

17 Colchester S.M.E.E. Members Slides. Clubhouse, Old Allotments, Lexden. 7.30 p.m.

17 Ickenham & District S.M.E. Members' Slides. Rear of Coach & Horses, Ickenham. 8 p.m.

17 Romford M.E.C. Bring and Buy Sale. Ardleigh House Community Centre, Ardleigh Green Road, Hornchurch, Essex. 8 p.m.

17 Stockport & District S.M.E. Film Show of locomotives by Mr. H. Singh. Wellington House, 324 Wellington Road North, Stockport 8 p.m.

17 Dublin S.M.E.E. "Springbok". Progress on Society's locomotive. In the Star of the Sea School, Sandymount, Dublin 4. 8 p.m.

17 Brighton & Hove S.M.L.E. Informal meeting. Elm Grove School, Brighton. 8 p.m.

17 Rochdale S.M.E.E. General Meeting. Technical College. 7.30 p.m.

20 Willesden & West London S.M.E. Social Night. Kings Hall Community Centre, Harlesden Road, London NW10. 8 p.m.

20 Stafford & District M.E.S Auction in aid of Club funds. Doxey Arms, Stafford 7.30 p.m.

20 City of Leeds S.M.E.E. Bits and Pieces. Salem Congregational Church, Hunslet Road, Leeds 10. 7.30 p.m.

21 Chelmsford S.M.E. Monthly meeting—Christmas Social Evening. Clubhouse, Waterhouse Lane. 7.30 p.m.

21 Derby S.M.E.E. Meeting—business to be confirmed. Carriage & Wagon Welfare, Derby.

22 Harrow & Wembley S.M.E. Marine Meeting. B.R. Sports Pavilion. Headstone Lane. 7.45 p.m.

22 Sutton Coldfield Railway Society. "Steam Cinema"—Roger Crombleholme (Cine). Wylde Green Library, Emscote Drive, Little Green Lanes, off Birmingham Road, Sutton Coldfield. 7.30 for 8.15 p.m.

22 Birmingham S.M.E. Annual Christmas 'Nosh' Night. Illshaw Heath. 8 p.m.

23 Sutton M.E.C. 8 mm. Film Night. Clubhouse, off Chatham Close, Sutton. 7.30 for 8 p.m.

23 Leyland, Preston & District S.M.E. Meeting. Roebuck Hotel, Leyland Cross, Leyland. Lancs. 8 p.m.

26 Sutton M.E.C. Boxing Day Track Run—weather permitting.

26 Guildford M.E.S. Boxing Day "Steam-Up". H.Q. Stoke Park. 10.30 a.m.

27 Colchester S.M.E.E. "Steam-Up". Clubhouse, Old Allotments, Lexden.

29 Sutton Coldfield Railway Society. "Personal Favourites"—Bill Thornber (Slides). Wylde Green Library, Emscote Drive, Little Green Lanes, off Birmingham Road, Sutton Coldfield. 7.30 for 8.15 p.m.

29 Cannock Chase M.E.S. Open Evening. Lea Hall Club. 7.30 p.m.

30 Sutton M.E.C. Conversation night. Clubhouse, off Chatham Close, Sutton. 7.30 for 8 p.m.

Hull S.M.E. Rummage Sale of any M.E. or useful items. Trades & Labour Club (Room 3), Beverley Road, Hull. 7.45 p.m.

JANUARY 1977

3 North Wales M.E.S. Society meeting. Penrhyn New Hall, Penrhyn Bay, Llandudno. 7.30 p.m.

4 N.W. Leicestershire M.E.S. Annual General Meeting. Miners Welfare Centre at Coalville. 7.30 p.m.

5 Guildford M.E.S. The 4 mm. Section are "at home" to others.

5 Bradford M.E.S. Talk on Mill engines.

5 Sutton Coldfield Railway Society. "Layout and Chit Chat". Wylde Green Library, Emscote Drive, Little Green Lanes, Sutton Coldfield. 7.30 for 8.15 p.m.

5 North Staffs. Models Society. Mr. Victor Barnes gives a talk on "Sheet Metal Work for the model engineer".

6 Harrogate M.E.S. Annual General Meeting. U.F. Church Hall, Raglan Street. 7.30 p.m.

6 Sutton M.E.C. Members' work. Clubhouse, off Chatham Close, Sutton. 7.30 for 8 p.m.

6 Harlington L.S. Members' models—anything BUT locomotives.

6 Warrington & District M.E.S. Talk by D. McHard (Marketing Director of Meccano). Clubroom, Daresbury. 8 p.m.

6 Leyland, Preston & District S.M.E. A.G.M. Roebuck Hotel, Leyland Cross, Leyland, Lancs. 8 p.m.

7 Romford M.E.C. Competition Night. Ardleigh House Community Centre, Ardleigh Green Road, Hornchurch, Essex. 8 p.m.

7 Torbay M.E.S. Meeting. Foxhole Community Hall, Paignton, Devon. 8 p.m.

7 Hastings S.M.E. "Recent Developments on the R.H. & D.R." talk by George Barlow. Mercatoria Hall, Mercatoria, St. Leonards-on-Sea. 7.45 p.m.

7 Stockport & District S.M.E. "Bits and Pieces". Wellington House, 324 Wellington Road North, 8 p.m.

7 Dublin S.M.E.E. "Work in Progress". In the Star of the Sea School, Sandymount, Dublin 4. 8 p.m.

10 Clyde Shiplovers' and Model Makers' Society. Old Glass Slides—Wm. Forth and John A. Smith. Kelvingrove Art Gallery and Museum. 7.30 p.m.

10 Swansea S.M.E. A.G.M. Club H.Q., Derwen Fawr. 7.30 p.m.

10 Wirral M.E.S. Film show—members' movies.

11 Guildford M.E.S. Executive Committee Meeting.

11 Stroud S.M.E. Starting a Workshop—Mr. P. Norman. Society's Workshops, Old Workhouse, Bisley Road, Stroud, Glos. 7.30 p.m.

12 Sutton Coldfield Railway Society. French Interlude—SNCF films introduced by Ivan Davies (Cine). Wylde Green Library, Emscote Drive, Little Green Lanes, Sutton Coldfield. 7.30 for 8.15 p.m.

13 Hull S.M.E. Safety in the use of Grinding Wheels. Talk by Mr. E. G. Bass. Trades & Labour Club (Room 3), Beverley Road, Hull. 7.45 p.m.

13 Sutton M.E.C. Aluminium Production and Use.—F. Kasz. Clubhouse, off Chatham Close, Sutton. 7.30 for 8 p.m.

13 Harlington L.S. Nomination Night—Members' Slides.

14 Chichester and District S.M.E. Talk and Films by Dave Nicholls on S. African Railways at the Boys' High School, Kingsham Road, Chichester. 7.15 p.m.

14 Wirral M.E.S. A.G.M.

17 North Staffs. Models Society. Talk and slides by Mr. David Bradbury "Traction and Stationary Engines".

19 Southampton & District S.M.E. Talk and slides by Mr. Peter Hollins—President of the Steam Boat Society of Great Britain.

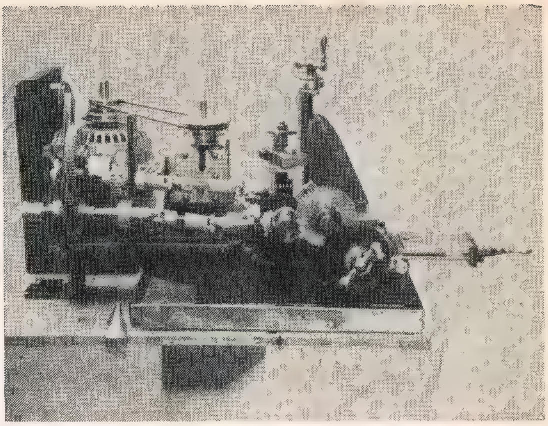
19 Sutton Coldfield Railway Society. More views of Shildon by Peter Johnson (slides). Wylde Green Library, Emscote Drive, Little Green Lanes, Sutton Coldfield. 7.30 for 8.15 p.m.

19 Guildford M.E.S. Bits and Pieces Competition.

20 Leyland, Preston & District S.M.E. Meeting. Roebuck Hotel, Leyland Cross, Leyland, Lancs. 8 p.m.

20 Warrington & District M.E.S. "General Meeting" Club House, Daresbury. 8 p.m.

The Editor welcomes letters for these columns. He will give a Book Voucher for £3.00 for the letter which, in his opinion, is the most interesting published each month. Pictures, especially of models, are also welcomed. Letters may be condensed or edited.



The gear machine from the operator's side.

Another "Portable"

SIR,—In view of the renewed interest in "portables", I have just turned out a photograph, reproduced from a Gas Board Works Magazine, showing a "portable" at Beckton Gas Works in 1868; it seems to be a "Clayton".

Note the tiny cylinder; it seems to be only 5 h.p.—size of man related to engine (seen driving two machines at once). It seems to have a flywheel of 5 ft. dia., boiler barrel say 2 ft. 3 in. (less lagging). Note wheels have cast iron rims and hubs of w.i. spokes.

Also the engine is blocked in place with wood; note the spark trap chimney top and filler cap on left-hand side of firebox.

Mill Hill, N.W.7. H. H. Nicholls

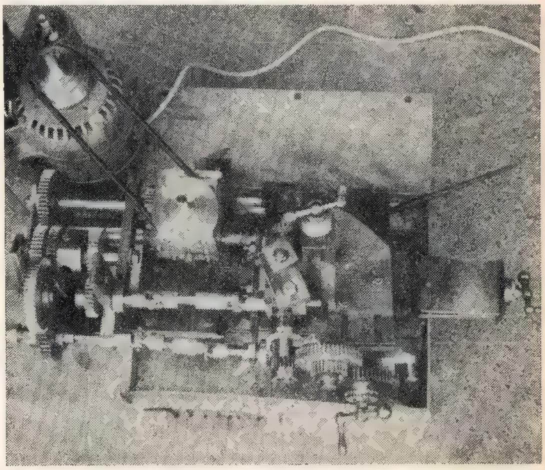
The photograph referred to is reproduced on page 1289.—Ed.

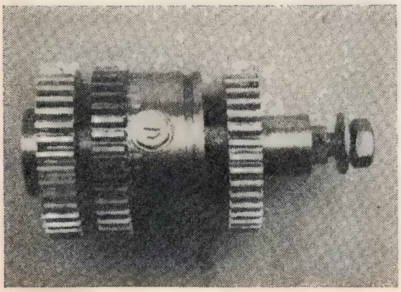
Gear-cutting

SIR,—Readers interested in gears and gear-cutting may like to know that I have succeeded in generating prime number gears on my little gear machine by making and using the "differential change wheel" suggested by Professor Chaddock. Three special spur gears and six bevel gears are used, and all were cut on the machine. The differential is similar to that used on nearly every motor car; two inward facing sun bevels independently rotatable about a common axis are connected by two planet bevels rotating about stub axles inwardly projecting from a planet carrier, which rotates about the same axis as the sun bevels. The principle of use is different from that in a motor car; if one sun bevel is rotated at X r.p.m. and the planet carrier rotated at Y r.p.m. the other sun bevel will rotate at $X + 2Y$ r.p.m., or $X - 2Y$ r.p.m., depending on whether the initial rotations are in the same or opposite directions. The factor of 2 can be understood by considering a planet bevel as an equal armed lever with the fulcrum at one end. A movement of the mid point will be doubled at the other end.

In the application on the gear machine, each of the sun bevels and the planet carrier has an external ring cut with 40 teeth of 20 D.P. The differential change wheel then forms part of a train of change wheels which is set up to generate a wheel with two teeth less than the number required, say 27 teeth when 29 teeth are required. The planet carrier is rotated, by means of a pair of bevels, a second universal jointed shaft, and another train of wheels on a second banjo, at the same speed as the work arbor. The second sun bevel then drives the index worm at a speed to generate 29 teeth in the blank.

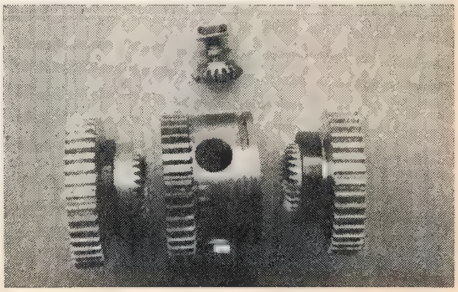
Below: The machine seen from above.





Left: The differential on its special stud.

Right: The components of the differential.



A few photographs of the machine set up for this purpose and of the differential are shown. Quite a lot of development work was necessary to get the arrangement to work well; the first trial resulted in all the gear wheels in use locking up solid! Most of the changes were intended to improve the rigidity of the set-up.

It will be seen from the photographs that the machine is again driven by its own semi-built-in motor; this motor is a Parvalux $\frac{1}{6}$ h.p. 2800 r.p.m. as supplied by M.E.S. for the Quorn cutter grinder, and seems to have ample power. I thought it too big to be carried on the cutter headstock of the machine; the arrangement with the spindle vertical enables it to drive the mandrel in either position of the cutter headstock, which it does through small cone pulleys, a home-made worm reduction gearbox, and pick-off gears. By this means a very wide range of speeds with close ratios can be obtained.

Argyll. T. D. Jacobs

Electric-powered Ships

SIR,—In his report on the Bristol Exhibition published in *Model Engineer* No. 3548, D. E. Lawrence asks if there were ever any straight electric-powered ships. I don't quite know what he means by the word straight, but there have been, in fact still are, electric-powered ships afloat. Perhaps for his interest and the interest of other readers the following may be of use.

About the 1950s the C.P.R. Shipping Company operated ships in which the final shafting and propeller were driven by an electric motor. I believe this Company had three or four of these ships and their names were prefixed by the word "Beaver", and were thus known as the "Beaver Boats". Electricity was generated by turbo-alternators and the speed of the vessel was effected by means of pole changing of the drive motor. Diesel generating sets were also installed which I believe could also be used for propulsion. I don't know if these vessels are still in service.

Type T2 tankers were also of the turbo-electric type but unfortunately I have no further information on these ships. Other companies also operated deep sea ships with similar propulsion schemes, the examples quoted by no means being unique.

To come to present times, there are on the Thames vessels owned by the Port of London Authority which are electrically driven. The *Broadness* and *Crossness* are salvage vessels used for wreck raising, river and estuarial work of all descriptions. They are twin screw vessels, each propeller being driven through a reduction gearbox by a variable speed reversible 250 h.p. D.C. motor. Power is supplied by two diesel-driven 220 volt D.C. generators running in parallel. In the event of one generator failing, the speed of the vessel is automatically limited to about half speed to continue its voyage. Speed control is by a boost system, a motor generator providing the necessary voltages. Control is direct from the bridge via an all-electric telegraph system which provides ten ahead speeds and ten astern speeds. Should the telegraph system fail, facilities are provided for engine-room control to be used with the same speed variation. Thus the vessels are with their twin rudders very manoeuvrable, a feature necessary for the type of work they are designed to undertake. Incidentally, everything else on these vessels is electrically driven, including the main salvage winch which is operated on the Ward Leonard principle. Power for this is supplied from a generator driven by the same motor that drives the propulsion boost generators.

There are also three floating cranes on the River Thames with electric propulsion. Two are in regular service and the third is used on odd occasions. The two larger vessels are each driven by two 750 h.p. 440 volt A.C. induction motors coupled to Voith-Schneider propeller units, one at each end of the vessel. The motors run at more or less constant speed, but the speed and also the direction of the vessel is controlled by the propeller units. These units are operated by a mechanical linkage from the bridge and provide the vessel with an extremely high degree of manoeuvrability very necessary in enclosed waters. The vessel is capable of being moved not only ahead and astern but sideways also. In fact it can be propelled in any direction throughout the 360 deg. Power for propulsion is supplied in each case by six diesel-driven 250 kVA alternators. The diesels are eight-cylinder turbocharged machines by Rolls-Royce and run at 1500 r.p.m. To give the vessels their service speed of about nine knots, it is necessary to run five of the alternators in parallel; the sixth being held in reserve. The vessels normally operate when not in the tideway with only three alternators running in parallel. The smaller vessel in this fleet has similar but smaller arrangements and consequently only three 250 kVA diesel alternators are installed.

I also believe that electrically-driven tugs operate on the London river, but I have not come across these personally so cannot provide information on them.

Hornchurch, Essex. R. O'Neill

Metrication

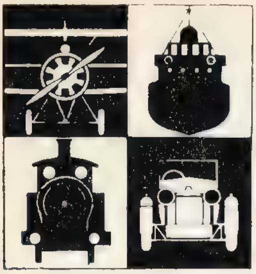
SIR,—I have read with particular interest the letter from Robert C. Hannum on the subject of Metrication in the 16 October issue, and would like to make the following observations.

I, too, deplored the onset of this change, and determined that, come what may, I would stick to the Imperial system, regardless of what Government and Industry decided was best. But already, I am having to give way, as it is easier to drill Metric holes and use Metric nuts and bolts, than search out Imperial sizes. So far, I have not bought Metric taps and dies, but it is only a matter of time . . .

One aspect that Mr. Hannum, and no doubt others who share his views, has probably overlooked completely is that, if the Editorial policy of *Model Engineer* was to do as he suggests and resist the use of Metric units, then, apart from the fact that contributors would have difficulty in describing how to make an item to Imperial dimensions from Metric stock, the hobby as a whole is going to lose. Schools in Britain are already producing young men and women who can recognise centimetres and millimetres, and are used to working in these units; to them inches and "thous" are alien and of historical interest. Unless *Model Engineer* accepts that Metrication is here to stay, and produces articles and drawings that these young people can understand, follow and work to, then they will turn away to something else, and the hobby will be the poorer. It may well be that people like Mr. Hannum (and myself) will have to turn back to our carefully preserved copies from the past, so that we can continue to work in the Imperial system.

You, Sir, have a very difficult course to steer, to cater for the established model engineers who do not wish to change habits of a lifetime, and yet offer a magazine which will ensure that our hobby goes forward from strength to strength. I trust your readers will consider my views as well as those of our Trans-Atlantic colleague, so that any protests which reach you are properly balanced.

Allestree. Alan Rimmer



46th Model Engineer Exhibition

4–15 JANUARY 1977

(not open Sunday)

At Wembley Conference & Exhibition Centre

LOCOMOTIVES, BOATS, AIRCRAFT, TRACTION ENGINES, MILITARIA, WOODWORK, CRAFTS

WHERE?

The Model Engineer Exhibition is moving to Wembley, and will be the first public exhibition to be held at the superb new Wembley Conference and Display Centre. If you've been through Wembley recently, this is the huge circular building on Empire Way, between the Empire Pool and the Squash Centre on one side, and York House and the London Esso Hotel on the other, all within a stone's throw of the famous Stadium.

As we have previously mentioned, the display area occupies two floors; these are at the rear of the Centre, reached through the main front entrance or, at extra busy times, through a second entrance at upper floor level, reached via a pedestrian walkway. Automatic ticket desks are expected to be in use at the main entrance, which should reduce queueing time to a minimum; any brief wait would be under cover.

WHEN?

The opening dates are Tuesday, January 4th to Saturday, January 15th, 10 am–8 pm daily, except the last day, when the Exhibition closes at 7 pm. It is not open on Sunday the 9th.

HOW ...

Much to go in? Admission at the door for adults will be 50p, children over 5 and still at school 30p, prices inclusive of VAT. Under 5s not yet at school are not charged.

Pre-booking tickets are available and avoid waiting. Single price for small parties of up to 10 adult 45p, child 25p. Parties of more than 10 adult 40p, child 20p. Teachers in charge of parties free in ratio of one per 10 in party. Family tickets are also available (in advance only) at £1.25 for two adults and two children plus 20p per extra child.

Visitors arriving after 7 pm will be entitled to entry at 30p. Season tickets are not normally available but the Exhibition Manager may be prepared to make specific arrangements in special circumstances.

TRAVEL

Rail travel to Wembley is available from Euston and Marylebone, but most travellers by public transport will probably use the Underground service; both Bakerloo and Metropolitan lines (via Baker Street) serve Wembley Park Station, which is five minutes' walk away, along the same road. Wembley Central Station is a little further away and has a limited Underground train service, but is an alighting point for some Birmingham/Euston main line trains.

By road, Wembley is easily reachable, lying only a minute or two west of the North Circular Road. Local permanent signposting to the Wembley complex exists over quite a wide radius, and although peak-hour traffic on the main roads in the vicinity can be quite heavy at times, it really is quite simple for drivers unfamiliar with London to reach the Exhibition without driving through the more confusing parts of the city.

There are extensive car parks adjacent to the Centre, and most people are glad to pay the modest charge for the convenience of parking close and without the worry of meter time running out. Coaches coming to the Exhibition only should make this clear, preferably by displaying a poster in the front window, otherwise they may be directed to the Ice Show coach park, which could mean that the coach could not be driven out until the end of the current performance.

CATERING

Wembley has extensive new catering facilities in the Centre itself, ranging from a tea/coffee bar and alcohol bar on the Exhibition upper floor to a snack and light refreshment bar and an attractive restaurant on the next floor. Prices and quality will, we believe, prove attractive, and group or party arrangements can be made in advance by writing to the Catering Manager, Wembley Conference Centre, Wembley, HA9 0DW.

COMBINATION TICKETS

Details are given elsewhere of facilities available for combination rail and accommodation 'packages' offering two nights in a choice of hotels plus rail fare and Exhibition entrance. These represent good value and offer an opportunity of, in effect, a three-day trip which could be used to take in that long-promised visit to, say, the Maritime or Science Museum etc, as well as a West End theatre or even the Oxford Street sales.

Clubs and families may like to know that details are being finalised for combination tickets covering the Exhibition and the adjacent Ice Show; this year it is 'Sleeping Beauty on Ice' and these Wembley spectaculars have a well-deserved reputation for quality and entertainment value. Unfortunately, it will not be possible to offer reduced combination tickets for Saturdays, but there are three Saturday performances of the show if the families want to go there while the modellers spend the time in the Exhibition.

OTHER ATTRACTIONS

With cinema and theatre facilities available in the Centre, film shows, talks and demonstrations of interest to Exhibition visitors are being arranged. What is on, and when, will be displayed on a board at the MAP stand and tickets will be available (at nominal cost only) to ensure that enthusiasts can reserve a seat at the feature of their choice without wasting time in queues. Full details are still to be finalised, but it is expected that talks and demonstrations on such subjects as lost wax casting, woodworking, boiler-making and the like will be taking place plus railway and aviation films. These are in addition to the many demonstrations which will be taking place on some of the 132 stands, including lathework, brazing, milling, and other workshop practices, lapidary, enamelling, wargames, miniature weapon-making, cart making, wood turning and machining, boat-building – a real feast of how to do it.

There is this year a special Woodworker 'show within a show' where expert advice on hand and power tools, and all aspects of carving, machining etc, will be displayed. This time, too, the demonstration area for electric flying models is at floor level, and this will permit the operation of R/C vehicles from time to time.

Many standholders have booked space for the first time, adding to the variety and choice of tools etc; they include model retailers, small gauge model railway suppliers, small lathes, specialist tool merchants, and so on.

Lots to see, lots to learn, lots to buy – you just can't afford to miss this 46th Exhibition!

Advance bookings and details from the Exhibition Manager
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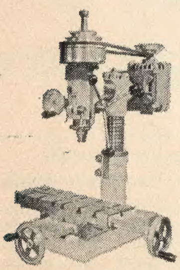

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